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Ekonomické studie a analýzy

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EDITORIAL

SCIENTIFIC ARTICLES / VĚDECKÉ STATĚ

FROM NEW ECONOMIC LITERATURE / Z NOVÉ EKONOMICKÉ LITERATURY

Editorial
Editorial

MOJMÍR HELÍSEK

Dear Readers,

The first this year´s issue of ACTA VSFS scientific magazine offers four papers covering a wide range of topics.

If you would like to become more knowledgeable of the relationship between exchange rate volatility and foreign trade, read the paper by Jana Šimáková The Gravity Modelling of the Relationship between Exchange Rate Volatility and Foreign Trade in Visegrad Countries. The empirical analysis uses territorial and commodity structuring of foreign trade data and is realized for the period 1999:Q1 – 2014:Q3. The research concludes that the exchange rate volatility leads to decreasing of foreign trade turnover on the bilateral level. The conclusions for the Czech Republic are of particular interest: the negative effect of exchange rate volatility was reflected in trade flows of food and live animals, animal and vegetable fats, machinery, transport equipment and miscellaneous manufactured articles.

In their paper, Determinants of Regional Entrepreneurial Activity in the Czech Republic Ondřej Dvouletý and Jan Mareš quantify factors that affect entrepreneurial activity expressed as rate of registered businesses per capita. They analyse entrepreneurial activity in 14 regions of the Czech Republic in 1995-2013. The regression estimates prove positive relationship between entrepreneurial activity in Czech regions and GDP per capita, unemployment rate and support activities of R&D institutions. The positive impact is also confirmed for population density, average age, share of tertiary educated population and real R&D expenditures. Good news is that GDP per capita is a good predictor of economic development of Czech regions.

Those who are interested in banking, will find captivating the paper by Otakar Schlossberger Economic and Legal Aspects of Electronic Money. The paper analyses mutual relationships between the terms "electronic money", "cashless money" and "virtual money" from the point of view of selected legal and economic approaches. A comparative analysis approach is applied to ascertain both the legal and economic differences between these categories and general conclusions are suggested employing the deduction method. Any changes in these terms may have a significant influence on the current practice with respect to the issuance and subsequent use of electronic money. The article is further concerned with the influence of these categories on the monetary base and money supply indicators.

The last paper by Daniela Spiesová Prediction of Emission Allowances Spot Prices Volatility with the Use of GARCH Models is based on the fact that the system of emission allowances trading has been dealing with a crisis mainly due to the falling prices of emission allowances. The reader will be acquainted with the development of emission allowances prices and subsequently with the prediction of the volatility of prices of emission allowances with the use of BAU scenario, i.e. without any external intervention. The aim of this article is to show

possible malfunction of EU ETS in the future based on the price development of EUA in time and on volatility prediction. The conclusions of the research suggest that in case of non-intervention of the European Commission the whole mechanism may fail.

In the section "From new economic literature" Jaroslav Vostatek reviews the book Social Policy by Vojtěch Krebs et al. It is not only a review, but also a commentary on current issues of Czech social policy.

I believe that you will find some of the papers offered captivating and that you will remain our loyal readers.

Mojmír Helísek
Executive Editor
University of Finance and Administration

Vážení čtenáři,

první letošní číslo vědeckého časopisu ACTA VŠFS Vám nabízí čtyři stati se širokým tematickým záběrem.

Chcete-li si rozšířit své znalosti o vlivu devizových kurzů na zahraniční obchod, seznamte se se statí Jany Šimákové Gravitační modelování vztahu mezi volatilitou devizového kurzu a zahraničním obchodem ve Visegrádské skupině. Empirická analýza využívá územní a komoditní strukturování zahraničního obchodu a je realizována v období 1999:Q1 - 2014:Q3. Výzkum dochází k závěru, že volatilita devizového kurzu vede ke snížení obratu zahraničního obchodu na bilaterální úrovni. Zvláště zajímavé jsou závěry pro Českou republiku: negativní vliv kurzové volatility se odráží v obchodních tocích s potravinami a živými zvířaty, živočišnými a rostlinnými tuky, stroji, dopravními prostředky a průmyslovým spotřebním zbožím.

Ondřej Dvouletý a Jan Mareš ve stati Determinanty podnikatelské aktivity napříč regiony České republiky kvantifikují faktory, které ovlivňují podnikatelskou aktivitu, vyjádřenou jako počet registrovaných subjektů na obyvatele. Analyzují podnikatelskou aktivitu ve 14 regionech České republiky za období let 1995-2013. Regresní odhady potvrdily pozitivní vztah mezi mírou podnikatelské aktivity v českých krajích a HDP na obyvatele, mírou nezaměstnanosti a podpůrnými aktivitami institucí vědy a výzkumu. Pozitivní vliv byl prokázán také pro hustotu obyvatel, průměrný věk, podíl terciárně vzdělané populace a výdaje na vědu a výzkum. Dobrou zprávou je závěr, že HDP na obyvatele dobře předpovídá budoucí ekonomický vývoj českých regionů.

Zájemce o bankovnictví určitě zaujme stať Otakara Schlossbergera Ekonomické a právní aspekty elektronických peněz. Stať analyzuje vztahy mezi pojmy „elektronické peníze", „bezhotovostní peníze" a „virtuální peníze", a to z pohledu právních a ekonomických přístupů. Komparativní analýzou jsou zjištěny jak právní, tak ekonomické rozdíly mezi těmito kategoriemi a metodou dedukce jsou definovány obecné závěry. Změny v těchto pojmech mohou mít značný vliv na současnou praxi při vydávání a následném využívání elektronických peněz. Stať také zkoumá vliv těchto kategorií na ukazatel měnové báze a peněžní zásoby.

Poslední stať Daniely Spiesové Predikce volatility cen emisních povolenek s využitím modelů GARCH vychází ze skutečnosti, že systém obchodování s emisními povolenkami prochází již několik let krizí především kvůli klesajícím cenám emisních povolenek. Čtenář se seznámí s vývojem cen emisních povolenek a následně s predikcí volatility jejich cen za předpokladu BAU scénáře, tj. bez jakýchkoliv vnějších zásahů. Cílem stati je na základě zkoumání vývoje cen emisních povolenek v čase a predikce volatility poukázat na možnou nefunkčnost Emissions Trading System v budoucnu. Výzkum dochází k závěru, že v případě neintervenování Evropské komise může dojít k selhání celého mechanismu.

V rubrice Z nové ekonomické literatury uvádí Jaroslav Vostatek recenzi knihy Vojtěcha Krebse a kol. Sociální politika. Jde nejen o recenzi, ale i o komentář k aktuálním problémům české sociální politiky.

Věřím, že Vás některé z nabízených statí zaujmou a zůstanete nadále našimi věrnými čtenáři.

Mojmír Helísek
výkonný redaktor
Vysoká škola finanční a správní, z.ú.

The Gravity Modelling of the Relationship between Exchange Rate Volatility and Foreign Trade in Visegrad Countries

Gravitační modelování vztahu mezi volatilitou devizového kurzu a zahraničním obchodem ve Visegrádské skupině

JANA ŠIMÁKOVÁ

Abstract

The paper focuses on the relationship between exchange rate volatility and foreign trade. The aim of this study is to evaluate the effect of exchange rate volatility on the foreign trade of Visegrad Countries on bilateral level as well as on the commodity level for different traded product groups determined by SITC classification. An empirical analysis uses territorial and commodity structuring of foreign trade data and is realized for the period 1999:Q1 – 2014:Q3. We use panel regression applied to the gravity model of foreign trade for analyzing the exchange rate volatility effects. Exchange rate volatility leads to decreasing of foreign trade turnover on the bilateral level. In the case of Slovakia, a negative effect on foreign trade was identified in all groups except chemicals, raw materials and raw materials for food purposes. For Poland was these effects detected for trade with mineral fuels, lubricants, animal fats, oils and waxes, while other products show their negative effects of exchange rate volatility on international trade. For Hungary, all statistically significant coefficients are negative and thus confirm the assumption of reduction of foreign trade turnover with increased exchange rate volatility. For the Czech Republic, the negative effect of exchange rate volatility was reflected in trade flows of food and live animals, animal and vegetable fats, machinery, transport equipment and miscellaneous manufactured articles.

Keywords

exchange rate volatility, foreign tade, gravity model, Visegrad Countries, sectoral analysis

Abstrakt

Článek se zaměřuje na vztah mezi kurzovou volatilitou a zahraničním obchodem. Cílem této studie je zhodnotit vliv kurzové volatility na zahraniční obchod zemí Visegrádské skupiny na bilaterální a komoditní úrovni pro různé druhy obchodovaných kategorií výrobků určených na základě SITC klasifikace. Empirická analýza tak využívá územní a komoditní strukturování zahraničního obchodu a je realizována v období 1999:Q1 - 2014:Q3. Pro analýzu účinků volatility devizového kurzu je využita panelová regrese, která je aplikována na model gravitačního zahraničního obchodu. Volatilita devizového kurzu vede ke snížení obratu zahraničního obchodu na bilaterální úrovni. V případě Slovenska je negativní vliv na zahraniční obchod identifikován ve všech skupinách s výjimkou chemikálií, surovin a surovin pro potravinářské účely. Pro Polsko jsou tyto účinky zjištěny pro obchod

s minerálními palivy, mazivy, živočišnými tuky, oleji a vosky, zatímco ostatní produkty potvrzují negativní dopady volatility kurzu na zahraniční obchod. V případě Maďarska, všechny statisticky významné koeficienty jsou negativní a potvrzují tak předpoklad snížení obratu zahraničního obchodu se zvýšenou volatilitou devizového kurzu. Pro Českou republiku, se negativní vliv kurzové volatility odráží v obchodních tocích s potravinami a živými zvířaty, živočišnými a rostlinnými tuky, stroji, dopravními prostředky a průmyslovým spotřebním zbožím.

Klíčová slova
volatilita devizových kurzů, zahraniční obchod, Visegrádská skupina, sektorová analýza

JEL Codes
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Introduction

The exchange rate volatility usually means uncertainty in international markets, therefore increasing of exchange rate volatility translates into decrease of the volume of foreign trade. This basic assumption, however, can not be applied across all countries. In this paper we expect that different product categories are characterized by different price elasticity of traded goods and exchange rate uncertainty faces to various degrees of risk aversion in every country. There are subjects with a variety of consumer and producer behavior patterns. This approach allows to isolate the specific effects of foreign currency fluctuations on specific product categories and also eliminates the shortcomings of previous studies caused by the use of aggregate data.

For the purpose of analyzing the effect of exchange rate volatility on foreign trade is chosen Visegrad Four (V4), which includes the Czech Republic (CZ), Hungary (HU), Poland (PL) and Slovakia (SK). From an economic perspective, it is a group of geographically close open economies located in Central Europe, which has successfully completed the transition process to the market economies. After significant political transformation and reforms, the V4 countries experienced significant changes in their foreign trade issues as well. This process began with redirecting trade from east to west, thus the structure and intensity of trade flows has significantly changed. Their initial limited interaction with the world economy was based more on the state restrictions then the market decisions and prices. Nowadays this former relatively isolated trade bloc has turned into a region which as a whole represents a significant share of world foreign trade.

In the area of international trade, it is not a completely homogeneous group, despite many common economic features of this countries. It can be presented in the openness of individual country which has been growing in time for each economy, but the total rate varies across them. This fact can be illustrated by using the share of foreign trade on their GDP between 1993 - 2014. For the Czech Republic this rate has increased from 74% to almost 150%, for Hungary from 63% to 156%, for Poland from 39% to 78% and for Slovakia from 91% to 173%. The transformation process in the V4 countries also reflected in the development of foreign exchange rates. Country abandoned the fixed exchange rate regimes and moved through different strategies in different times toward a flexible exchange rate regime. Moreover, Slovakia, as the first of V4 countries has joined the euro area. For the rest

economies results of this study may serve as one of the arguments for further decisions on their exchange rate policy. The country with the high rates of participation in foreign trade and a gradual inclination to floating exchange rates make the V4 countries eligible for this research. Paper takes into account the territorial and commodity structure of V4 foreign trade. Therefore the aim of this paper is to evaluate the effect of exchange rate volatility on the V4 foreign trade on bilateral level as well as on the commodity level for different traded product groups.

To this end, the next section reviews relevant literature published in the examined field. The following section introduces the empirical model and data used in estimation. The next section presents and discusses the empirical results. Finally, the last section makes conducting remarks.

1 Literature Review

Sustained misalignment of exchange rates away from levels that reflect inflation or cost differentials sends incorrect price signals which could destabilize international trade flows. Furthermore, variability of exchange rate could inflict adjustment and resource misallocation costs on an economy if it changed investment decisions and results in shifts in resources between the sectors of an economy that were not justified by relative cost and productivity differentials; and may destabilize levels of protection against foreign competition provided by price-based trade restrictions, generating pressure for compensating trade restrictions to protect current patterns of supply (IMF, 1984). Economic literature shows the general assumption of negative effects of exchange rate risks on foreign trade, but this assumption is highly conditional. There can be found a theoretical explanation for the negative but also for the positive impact of exchange rate volatility on foreign trade.

1.1 Negative Effect of Exchange Rate Volatility on Foreign Trade

Clark (1973) models situation with hypothetical company operating in perfect market conditions, which produces only one kind of commodity. Its production does not import any intermediate inputs and is intended solely for export markets. The company only accepts payments in foreign currency, thus the total revenue from its exports in local currency are dependent on (unpredictable) exchange rate level. Uncertainty about future exchange rates is directly reflected in uncertainty about future income in local currency. Therefore, in a situation in which the variability of profits depends only on the exchange rate, greater exchange rate volatility results in a reduction of production and exports, reflecting exposure to risk. Ethier (1973) shares this view, arguing that exchange rate volatility has a negative impact on the volume of foreign trade, while the negative effect is not removed even by the existence of a forward or futures hedging, as their markets can not completely neutralize the risk. Baron (1976) removes almost unreal perfect competitive markets and analyzes the effect of exchange rate volatility on price developments, with a focus on the role of invoicing currency. According to Baron (1976) the exporters may diversify its foreign exchange risk by mixed billing in domestic and foreign currency (depending on their market power) but still face a certain amount of risk. If the exporter invoiced in foreign currency, the quantity demanded for its exports is unchanged, as prices in foreign markets

remain the same. However, it changes the realized and expected revenues as well as its cost. On the other hand, if the exporter invoiced in the local currency, the uncertainty facing the demanded quantity of goods to buyers because enters the uncertainty associated with prices. Unless the company invoicing in foreign currency, then the increase in risk translates into rising prices, because higher price minimizes the expected returns, but also increases the expected benefits. In case of invoicing in local currency, the overall effect changes depend on the characteristics of demand in the export market.

Paper by Hooper and Kohlhagen (1978) differs from previous studies as it does not focus on one side of the market, but defines the market equilibrium, which includes export supply and import demand. Importers and exporters, who bear the foreign exchange risk are companies maximizing their revenues. Overall, this model aimed at the effects of exchange rate volatility in prices and volume of trade preferences crucial importers and exporters regarding risk, market share of the parties on the level of risk and hedging against exchange rate risk. From the perspective of the importer (the exporter applies vice versa), part of the contract is nominated in local currency and only a sub-importer's contract is hedged. This creates uncertainty which affects the equilibrium price and quantity of goods on the market. Risk aversion can then have a double impact on the price. Risk averse importers inquire fewer goods, thus will decrease the amount of traded goods, and its price. Risk averse exporters reduce the total quantity of offered goods, the price will rise because of the risk premium. In both cases, with increasing exchange rate volatility, the total trade volume decreases.

Uncertainty generated by currency fluctuations can be eliminated by hedging instruments. However, companies have equal access to hedging and may behave differently depending on which side they are. Baron (1976) shows that if the sole source of uncertainty just exchange fluctuations, perfect forward markets neutralize the effects of exchange rate volatility on trade volume. Viaene and de Vries (1992) add that the forward markets create winners and losers among exporters and importers who are on opposite sides of the forward transactions. Caporale and Doroodian (1994) suggest that although companies have hedging instruments relate to them the costs and problems associated with the lack of foresight of participating companies, especially as regards the timing and volume of foreign exchange transactions. Furthermore, Obstfeld and Rogoff (1998) state that cost of the foreign exchange risk hedging leads to higher export prices, resulting in a negative impact on production and consumption.

1.2 Positive Effect of Exchange Rate Volatility on Foreign Trade

In some theoretical models, the impact of increased exchange rate volatility on trade flows depends largely on trader's aversion to risk. The risk-neutral traders are unlikely to be affected by exchange rate uncertainty. Paradoxically, the very risk-averse traders might just trade more, as a response to increased volatility in order to offset the expected decline in revenue per exported unit. De Grauwe (1988) states that in general, exporters are negative affected by exchange rate volatility, however, they can decide to export larger volumes of goods. The positive impact is determined by the dominance of the income effect over the substitution effect. According to Franke (1991), the increase in export volumes of companies facing exchange rate volatility depends on the optimal time adjustment of en-

tries and exits from foreign markets. Franke (1991) explains that the company in a time of increased volatility may earlier or later enter or leave the international markets. As a result of timing differences can increase the number of internationally trading companies and thus the volume of foreign trade. Viaene and de Vries (1992) attribute the positive effect of volatility due the fact that importers and exporters are on opposite sides of risk aversion, their position is reversed and thus leads to a positive effect of volatility for one of them.

Several theoretical models illustrate the effects of the exchange rate volatility more depending on the composition, than on the gross level of activities. Kumar (1992) shows that while the relationship between exchange rate fluctuations and gross value of trade is ambiguous, fluctuations have a positive impact on inter-trade. The logic of the argument is that the risk of exchange rate acts as a tax on the comparative advantage of the exporting sector versus sector locating production in the domestic market and intra-trade will increase. In this model, the exchange rate risk reduces net trade, which is the difference between gross and intra-trade. The existence of a positive relationship between exchange rate volatility and export is theoretically confirmed for companies that are able to respond flexibly to changes in exchange rates and are able to allocate the products between domestic and foreign markets (Broll and Eckwert, 1999). By using such a process, it is possible to optimize the trade revenues in an environment of increased volatility. Redistribution has its limitations and it works only if the traders have a sufficient domestic market, where they can place their productions. In this case, the domestic market acts as a market sure (Auboin and Ruta, 2013).

1.3 Empirical Testing of Exchange Rate Volatility on Foreign Trade

Early studies were performed mainly at the aggregated level. Aggregated data of foreign is given there as a volume of trade flows from respective country to all trading partners, respectively, to the rest of the world. Early studies are performed by using basic regression methods, while the dependent variable is mostly export, which is given as a function of world GDP, relative prices and exchange rate volatility. Aggregate trade flows analysis can be found for example in papers by Arize (1998), Arize and Ghosh (1994), Arize and Malindretos (1998), Doroodian (1999), Arize et al. (2000), Bahmani-Oskooee (2002), and Arize et al. (2003). The results of studies presented at the aggregate level, provides mixed results, but there is a clear dominance of proved negative impact of exchange rate volatility on the import and export flows. Bahmani-Oskooee and Hegerty (2004) attributes the mixed results to usage of different econometric analysis, a proxy variable for the choice of exchange rate volatility and also aggregation bias.

Hooper and Kohlhagen (1978) conducted one of the first bilateral studies. For the US – Germany trade in the period 1966 – 1975 they conclude that volatility has no statistically significant impact on the volume of bilateral trade, but also notes that this fact is obviously influenced by short-term volatility, the use of which is thought to cause a failure to effect long-term volatility. Cushman (1986) models the volume of exports from the US to the UK, the Netherlands, France, Germany, Canada and Japan, while the OLS model adds to the risk of a third country. Cushman (1986) concludes that these effects must be included in the formulation of business model to capture the indirect and direct risks, and notes that not including these factors can lead to an overestimation result of direct (bilateral) risks.

Although Cushmann (1986) confirms the negative impact of volatility on foreign trade, the current trend is to omit the effects of third countries (Bahmani-Oskooee and Hegerty, 2004). Cushman (1988) with further analysis of foreign trade of the United Kingdom, the Netherlands, France, Germany, Canada and Japan shows the expected negative effect of exchange rate volatility for 10 of the 12 trade flows, trade flows with Japan in this study show a positive impact. The cause of the disparity of results was considered by Cushmann (1988) as a result of proxy calculation of exchange rate volatility and the forward rate. Negative effect of exchange rate volatility on the volume of foreign trade is also confirmed in other bilateral studies, for example Dell'Ariccia (1999), Rose (2000), Tenreyro (2007). By the contrast, studies by Frank (1991) and Sercu Vanhulle (1992) show a positive impact.

As can be seen, empirical results provide mixed results. It can be caused by the choice of the data sample, as the trade balance of the country tends to react differently to exchange rate shocks (Baum et al., 2004). According to Clark et al. (2004) may be reason for the diversity of effects of exchange rate volatility in the various traded product groups. Earlier studies mostly tested the relationship on aggregate data, but trade flows of various goods may react to exchange rate uncertainty in different ways. Such differences may be caused by different duration of trade contracts, availability and cost of hedging against exchange rate risk or sensitivity to price changes in various sectors of foreign trade. Then the whole structure of foreign trade may infuence the effect of volatility on foreign trade as a whole (Johannsen and Zarzoso, 2013).

First sectoral analyses are applied on the aggregate data of the country for various product categories. Coes (1981) analyzes 13 different industry groups (mineral products, rubber products, transport equipment, textiles and nine primary products) determining the volume of exports as a linear function of exchange rate volatility, relative prices and foreign income. The study uses OLS for the period 1957 - 1974. Coes (1981) finds that all manufactured goods are affected by a statistically significant effect of exchange rate volatility, most of which are positive. The negative effect appears only in the case of beverages and rubber products. The results for agricultural products show weaker effects compared to industrial goods. Coes (1981) in the first empirical study for sectoral data shows that the agricultural and industrial goods are affected by various effects of exchange rate volatility. Different effects of exchange rate volatility between industrial and agricultural products are showed also by Maskus (1986). In his study, data are divided not only to the sector level, but also to the geographical level and focuses on trade between the US and Japan, the United Kingdom, Germany and Canada. Analysis for the period 1974 - 1984 shows that the exchange rate volatility most affects trade flows with Germany and the most affected sector was agriculture. The results for agricultural trade show negative effect of exchange rate volatility what is contrary to Coes (1981). Maskus (1986) provides the basis for sectoral analysis and was followed by many others studies (e.g. Klein, 1990; Belanger et al., 1992; Stokman, 1995).

Even through disagregation to teritorial and bilateral trade, we can find mixed conclusions. Other empirical studies therefore apply this principle, but follow also the econometric progress. Many studies use various cointegration techniques, often reflect foreign trade as a simple linear function of income, relative prices and exchange rate uncertainty. Rapp and Reddy (2000) has applied the Johansen cointegration procedure on the export

flows from the US to the G-7 in the period 1978 - 1995. The analysis includes eight sectors and exchange rate volatility calculated as a standard deviation. However, this study again provides mixed conclusions. From the 39 cointegration vectors, 18 confirmed statistically significant negative coefficient of exchange rate volatility and vice versa 14 showed a statistically significant positive coefficient. These effects differ across sectors and countries and can not be generalized.

The other sectoral analysis based on cointegration technique use proxy for exchange rate volatility calculated on the basis of ARCH model. Doyle (2001) tests the trade flows between Ireland and the United Kingdom and notes that a small open economy and its producers placing goods on the international market have no choice, only to accept the foreign exchange risk. Multinational corporations, however, according to him, can diversify risk and reduce the impacts of uncertainty. ARCH modelling of the volatility is used in many other studies (e.g. Bredin et al., 2003; Chou, 2000; De Vita and Abbott, 2004; Bahmani-Oskooee and Wang, 2007; Bahmani-Oskooee and Mitra, 2008; Bahmani-Oskooee et. al, 2012), and gradually penetrates into the panel analysis. Peride (2003) applied panel regression to analyze export demand and import supply for the G-7 with its key trading partners. Author notes that competitors, pricing strategies, and costs are specific for each sector, and therefore every industry reacts different to fluctuations of foreign exchange rates. Peride (2003) concludes that the use of GARCH model in calculating the proxy exchange rate volatility provides in this case the results for all countries more statistically significant. He highlights not only the geographical but also the sector characteristics influencing the results. While some fuels, natural products, or textiles are heavily influenced by exchange rate volatility; industrial goods and machines have lower degree of influence. Peride (2003) suggests that the weaker effect of exchange rate volatility is caused by the product differentiation in this sector.

Ozturk (2006), or Auboin and Ruta (2013) provide a fairly comprehensive overview of other empirical surveys on the impact of exchange rate volatility. These reviews show that there is a relatively wide deviation of the conclusions. Some of them confirm the hypothesis of a negative relationship between exchange rate volatility and foreign trade, others not. Furthermore, Taglioni (2002) states that even some studies confirm the fact that exchange rate volatility decreases trade flows, this effect is definitely not great.

1.4 Empirical Studies for Visegrad Countries

Most of the empirical studies are focused on the major countries in terms of global economic power. Nevertheless, it is possible to find several analyzes focusing on the V4 countries. Égert and Morales- Zumaquero (2005) analyze the direct impact of exchange rate volatility on export performance in ten Central and Eastern European transition economies, as well as its indirect impact through changes in exchange rates regimes. Study looks not only on aggregate but also on bilateral and sectoral export flows. For this purpose, the authors analyze shifts in exchange rate volatility and subsequently construct the indicator variables utilized in the export function. The authors conclude that the exchange rate volatility reduces V4 export. Cociu (2007) also examines the relationship between exchange rate volatility and foreign trade of Eastern and Central European countries. Author uses a panel regression and applies it to the aggregate data for the period 1995 - 2006.

By using real effective exchange rate is found that exchange rate volatility has a negative impact on foreign trade. Author also divides the country into two groups according to the degree of openness. This study empirically shows that the negative impact is higher in countries with greater openness, which includes the Czech Republic, Hungary and Slovakia. Contrary, less influence was demonstrated for Poland, whose openness is lower. Tomanová (2013a) analyzes the impact of exchange rate uncertainty on exports of the Czech Republic. She focuses on three different periods with respect to the financial crisis. In her study is used vector error correction model. According to the reults, exchange rate volatility has no statistically significant relationship with exports even in the pre-crisis, crisis or post-crisis period. Tomanová (2013b) in another study estimates the impact of exchange rate volatility on export performance of Central European countries into the euro area, but even in this case there is no significant results.

Ozturk and Kalyoncu (2009) use gravity model and find evidence that exchange rate volatility has a negative impact on foreign trade of Poland, but in the case of Hungary these effects are positive. Gravity model was used also by Ferto and Fogarasi (2012). The study examines transition economies of Central Europe in 1999 - 2008. The results show that the nominal exchange rate volatility has a statistically significant negative effect on agricultural foreign trade. Šimáková (2013a) uses gravity model to analyze the effects of exchange rate volatility on bilateral trade of Poland with 19 trading partners in the period 1997 - 2012. Exchange rate volatility is calculated as a standard deviation. The results of panel regression confirmed for Poland statistically significant negative impact of exchange rate volatility of the Polish zloty on its foreign trade. The same econometric technique was also used by Šimáková (2014b), who analyzed the impact of exchange rate volatility on bilateral trade flows in Hungary. In panel regression in this analysis were included 12 major trading partners. The results also confirm that the nominal exchange rate volatility of the Hungarian forint have a statistically significant negative impact on bilateral trade over the period 1997 - 2012. For the Czech Republic, similar research was conducted by Šimáková (2014c) by using the data for 17 trading partners. Contrary, for exchage rate volatility calculation was used generalized ARCH model. Even for the Czech Republic, it is confirmed the negative impact of the volatility of nominal exchange rate on the total realized bilateral foreign trade. For Czechia, Babecká Kucharčuková (2014) applies both static and dynamic version of the gravity model on panel data for its 38 trading partners in the period 1999 - 2008. The study leads to the same conclusions as Šimáková (2014c) and also shows that magnitude of exchange rate volatility is greater while using a dynamic model.

Studies at the aggregate level provide important results about the prevalence of negative impact, but there can be possible bias of results. Distortion caused by the aggregation of data is a potential problem if the bilateral trade flows with different partners, although manifest as both positive and negative relationship with exchange rate volatility, but these interactions are smoothed at the aggregate level. Empirical analysis at the teritorial level allows the use the bilateral exchange rates (instead of effective exchange rate). Moreover, the response of the trade to fluctuations in exchange rate may vary by country, depending on the nature of trade. For these reasons, aggregating of data could obscure the fundamental individual and different dynamics of bilateral relations, which would lead to erroneous conclusions at a general level and neglect the consequences on the bilateral level. Recent studies disaggregate trade also on the level with respect to commodities or

sectors. Testing of sectoral data helps further reducing of distortion caused by aggregation. The use of product-level data also allows the identification of sectors that are more affected by fluctution of the exchange rates. This approach enables to isolate the specific effects of exchange rate volatility on specific goods. Hence this paper is based on the teritorial and product disaggregating.

2 Data and Methodology

A situation in which the observed relationship seems to be ambiguous and highly conditional, leads to the need for more sophisticated models with several countries, different commodities, and other factors directly related to foreign trade. The current tendency is to use gravity model. Leamer and Levinsohn (1995) argue that the gravity model produces the brightest and most robust findings in empirical economics, and thus represents a sufficient basis for assessing the impact of different variables on foreign trade. Foreign trade in the gravity models is usually based on the assumption that acceleration of their common trading activities is given by distance between the two countries and the size of their markets. This model is derived from Newton's law of gravity, thus describes the force of gravity in the form of trade flows between pairs of countries, commensurate with their economic "weight" (national income) and inversely proportional to the distance between them. Tinbergen (1966) uses this universal law to model the foreign trade as:

$$TT_{df} = \delta \frac{Y_d^{\beta_1} Y_f^{\beta_2}}{D_{df}^{\theta}} \tag{1}$$

where the volume of foreign trade between the two countries TT_{df} is directly proportional to their income $Y_{d(f)}$ and inversely proportional to the distance between them D_{df}.

Use of gravity model was initially based on intuition rather than on economic theory. This often criticized deficiency is gradually withdrawn, as gravity equation corresponds to basic microeconomic model of foreign trade. Some economists argue that this is not just a purely econometric tool without theoretical basis but it is considered a model consistent with trade theories with imperfect competition of Heckscher-Ohlin theory. Bergstrand (1989) shows that countries trade differentiated goods, because consumers prefer diversity. Deardorff (1998) adds that the gravity model can arise from the traditional business model based on the proportions of production factors. Eaton and Kortum (2002) derive a gravity equation from Ricardian model. Carrere (2005) explains his theoretical foundation by imperfectly competitive environment through increasing returns to scale and product differentiation at the company level, in perfect competition again through product differentiation at the national level. Helpman et al. (2008) and Chaney (2008) obtained it from the theoretical model of international trade in differentiated goods with the assumption of heterogeneity of companies. For the purpose of this paper is used Dell'Ariccia´s gravity model (1999), which extends the original gravity equation in the form:

$$\begin{aligned} lnTT_{df} = \alpha + \beta_1 lnY_d + \beta_2 lnY_f + \beta_3 lnPOP_d + \beta_4 lnPOP_f + \beta_5 lnD_{df} \\ + \beta_6 lnV(ER) + \beta_6 lnCB_{df} + u_{ij} \end{aligned} \tag{2}$$

which is based on the assumption that countries with greater economies tend to trade more (in absolute value) as they form larger demand and supply. In addition to the domestic (Y_d) and foreign (Y_f) income, the model includes variables of population $POP_{d(f)}$ to characterize their economic size. Hence, with increased demand and supply of internationally traded goods, we expect the increase of total volume of foreign trade and therefore positive coefficients of these parameters. Greater distance between countries D_{df} decreases the bilateral trade, as it means higher transportation costs, prolongation in delivery time and higher cost of finding alternative business opportunities. The estimated coefficient is thus assumed in negative signs. By analogy, these factors are eliminated by common borders *CB*, which should positively contribute to the volume of foreign trade between the countries. The model further assumes a direct relationship between the volatility of foreign exchange rates *V(ER)* and trade flows TT_{df}, as risk aversion subjects reduce the volume of business due to rising costs of hedging against exchange rate risk. Possibly they can leave international markets totally. For the sectoral analysis the model is adjusted to the equation:

$$lnTT_{p,df} = \alpha + \beta_1 lnY_d + \beta_2 Y_f + \beta_3 lnPOP_d + \beta_4 lnPOP_f + \beta_5 lnD_{df} + \beta_6 lnV(ER) + \beta_6 lnCB_{df} + u_{ij} \quad (3)$$

where$TT_{p,df}$ represents the volume of trade carried out within individual product categories.

2.1 Modelling of Exchange Rate Volatility

Although the earlier studies assessed the exchange rate volatility by using the standard deviation, it has some limitations that can be eliminated by using autoregressive model of volatility. In particular, ARCH model was first applied by Engle (1982). ARCH model is based on two predicates: (i) time series models are heteroscedastic, with the volatility variable over time; (ii) volatility is a simple quadratic function of the predicted past errors (deviations from the conditional averaging). The first ARCH models are affected by some drawbacks which can be eliminated by generalized ARCH (GARCH) model, which allows to model volatility as depending variable on its previous values. GARCH model (m, s) has the form:

$$y_t = \mu_t + e_t, \qquad e_t = \sigma_t \varepsilon_t, \qquad \sigma_t^2 = \alpha_0 + \sum_{i=1}^{m} \alpha_i e_{t-i}^2 + \sum_{j=1}^{s} \beta_j \sigma_{t-j}^2 \quad (4)$$

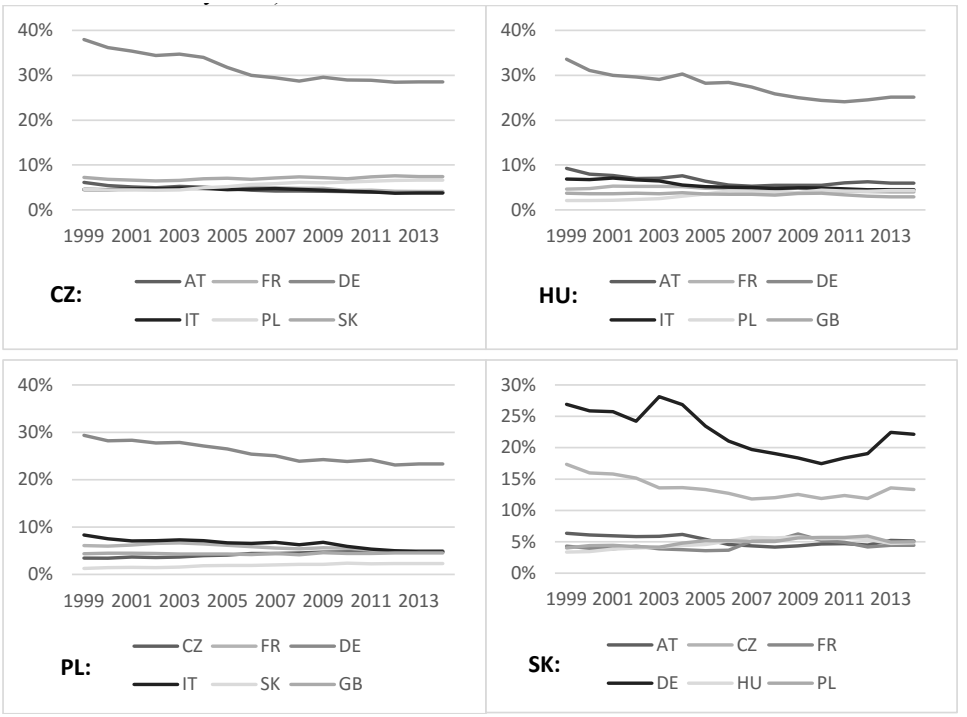
where ε_t are random variables with zero mean and unit variance and parameters of model meet $\alpha_0 > 0$; $\alpha_i \geq 0$; $\beta_j \geq 0$; $\sum_{i=1}^{max\{m,s\}} (\alpha_i + \beta_i) < 1$. Peride (2003), in his study focused on the analysis of panel data of foreign trade, concludes that the use of GARCH modeling in estimating the proxy for exchange rate volatility creates more statistically significant results. Therefore, this kind of volatility modeling will be also used in this paper.

2.2 Data

This paper analyzes effects of exchange rate volatility on V4 foreign trade in the period 1999:Q1 – 2014:Q3. The paper distinguishes foreign trade at two levels, namely the territory and commodity. Territorial composition of foreign trade is understood as a share of partner countries on total trade operations expressed in value. By the territorial view

can be seen which countries are the most important importers and exporters of V4 countries. Currently, approaches to the foreign trade statistics are fragmented in two basic approaches. The first is based on the principle of the transfer of goods across the border and is in line with the so-called traditional foreign trade statistics. Exports shall be understood as physical crossing of goods across the border to foreign countries. The exports and imports are counted as well as transactions by non-residents on the territory of the country. This statistic describes only the physical movement of goods across borders, regardless of whether there is trade between domestic and foreign entities. The second approach is based on the change of ownership and is thus consistent with the construction of balance of payments and national accounts. Although this statistic is a good starting point for the compilation of balance of payments of the country, cross-border statistics has its foothold in the global methodological manual of the International Merchandise Trade Statistics and the European Union legislation. If individual countries consistently applied the principle of change in ownership, the data would not be consistent bilaterally. Hence, for the purposes of this paper is used cross-border statistics, which is comparable internationally and can serve as an indicator of the value of trade in the selected countries.

Figure 1: Development of Territorial Structure of V4 Foreign Trade (share on total foreign trade of the country in %)



Source: authors' calculations based on data obtained from OECD database

Note: The abbreviation explanation: Austria (AT), France (FR), Germany (DE), Great Britain (GB), Italy (IT)

The bilateral analysis uses cross-border trade data between a particular country and its six major trading partners. The selection of partner countries represents at least 50% of

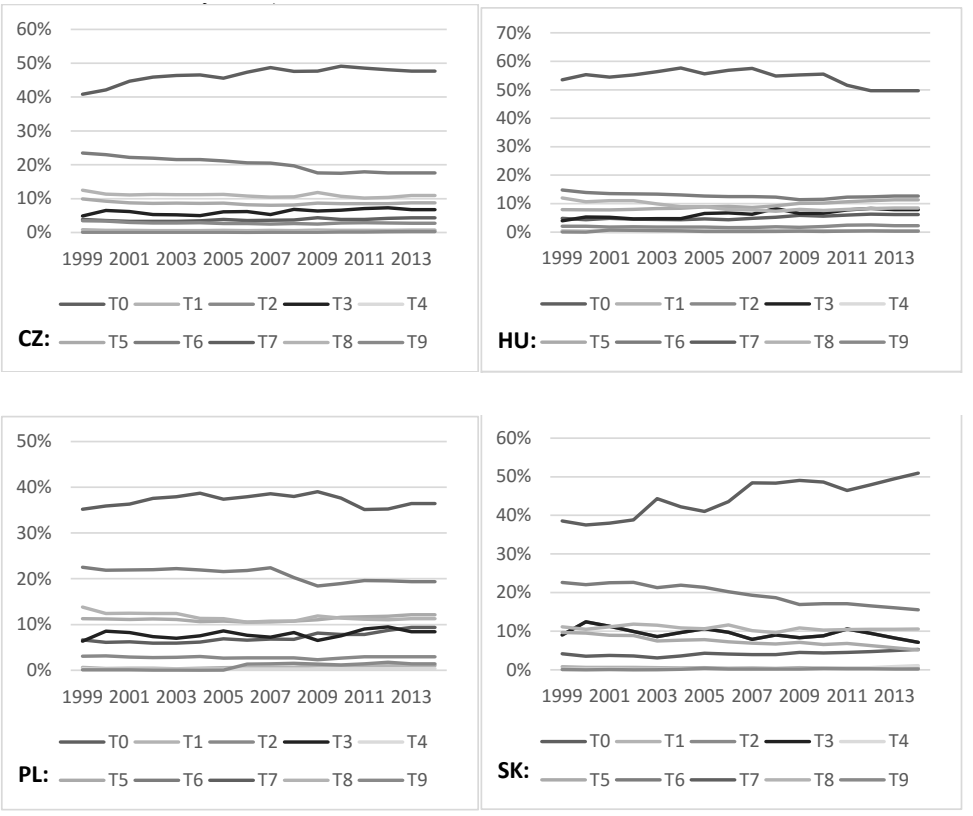
the total foreign trade turnover of each V4 country. Figure 1 shows the shares of major trading partners of the V4 countries on their total foreign trade turnover. It can be seen that the V4 countries focuse on the similar export markets and their regional similarity of consumer behavior translates also to their mutual trade. Approximately 25% of total V4 trade is realized with Germany. Foreign trade of the V4 is so clearly influenced by german economic development, although it must be noted that the share is decreasing in time. Slovakia has one more significant partner, which is beyond the average of other observed trade – the Czech Republic. Bilateral trade between these two countries is based on the long-term economic ties. Even from the perspective of the Czech Republic, Slovakia is the second most important foreign market. In general, the V4 countries implement foreign trade thanks to barrier-free trade with EU countries (almost 80% on average). Among major trading partners belonging to non-EU countries with lower share on V4 foreign trade are markets supplying goods in lower price levels (USA, China), long-term strategic partners (Russia) or territory of foreign direct investment (South Korea).

The product analysis of foreign trade monitors shares of individual product categories on total imports and exports. Classification of commodities used in the paper is determined by the Standard International Trade Classification (SITC), which divides traded goods in the 10 classes. Result of this classification is the segmentation of the commodities not only by the type of material from which they occurred but also by their economic purpose and level of processing. Basic SITC classes are:

- T0: Food and live animals;
- T1: Beverages and tobacco;
- T2: Crude materials, inedible, except fuels;
- T3: Mineral fuels, lubricants and related materials;
- T4: Animal and vegetable oils, fats and waxes;
- T5: Chemicals and related products;
- T6: Manufactured goods;
- T7: Machinery and transport equipment;
- T8: Miscellaneous manufactured articles;
- T9: Commodities and transactions not classified elsewhere in the SITC.

The share of individual SITC categories on total V4 foreign trade can be seen in Figure 2. There is visible dominance of traded SITC category T7, whose average share of trade flows in the sample period is 47% in Czechia, 57% in Hungary, 37% in Poland and 44% in Slovakia. Another important traded category is T6, which for the Czech Republic, Poland and Slovakia represents another 20% share, respectively 13% in case of Hungary. T8 group represents about 10% share in each analysed country. V4 economies are concentrated in trade of manufactured goods, machinery, transport equipment and other manufactured products with higher added value.

Figure 2: Development of Commodity Structure of V4 Foreign Trade (share on total foreign trade of the country in %)



Source: authors' calculations based on data obtained from OECD database

Exchange rates *ER* in the model are ussed in direct quotations of nominal bilateral exchange rates. This is in accordance to arguments of Auboin and Ruta (2013) that the choice between nominal and real exchange rate does not affect the econometric results. Data of exchange rates are derived from the Eurostat database. Income Yd respectively Yf, is represented by GDP of each country in current prices. Foreign trade and GDP are at a quarterly frequency and are derived from the OECD database. GDP is transferred to the index (unitless) form, as recommended by Bahmani-Oskooee (1991). Data of population $POP_{d(f)}$ are also obtained from the OECD database. Data of the distance between the V4 countries and their business partners are taken from the GeoDist database. The bilateral distances are measured using city-level data. Capital city is considered to be the economic center in all countries included in the estimations.

3 Results and Discussion

To examine the effect of exchange rate volatility on the foreign trade turnover is used a gravity model based on Dell'Ariccia (1999). *TT* is the sum of the values of total exports and imports in bilateral flows of major trading partners. The TT_p is trade turnover calculated as

the sum of exports and imports in individual SITC product category for each selected trading partner. To model the volatility of exchange rates is used GARCH model. Volatility is calculated on monthly data, while their quarterly values are calculated as a quarterly average of its monthly values. The panel regression modelling of foreign trade turnover in individual product categories includes six cross sections (trading partners) and 63 periods (1999:Q1 – 2014:Q3). Heteroscedasticity is examined by using White's test and the appropriateness of the model in terms of autocorrelation is verified by Durbin-Watson statistics which estimates in this analysis range from 1.7 to 2.2.

3.1 Results for Czechia

The majority of estimated parametres for Czechia are statistically significant. As shown in Table 1, the insignificance can be observed mainly in the distance coefficient, population size and common border. In product group analysis, we can observe the expected positive effect of GDP growth on foreign trade. Estimated impact effect of Czech GDP seems to be generally greater than that of foreign income (excluding product groups T1 and T2 representing 4% of the total foreign trade). Theoretical expectations of positive impact of the growth of population size are empirically validated for product groups T4, T5, T7, T8 and T9. This trade represents 68% of the total foreign trade. With an increase of population of Czechia and its trading partners we expect increased demand for goods traded between their markets. For product categories T5 and T7 is estimated negative effect of distance between economic centers. While in the product group T5 is estimated the expected inverse relationship of foreign trade turnover and the common border between trading partners.

Product-level analysis for each SITC category further shows that the impact of exchange rate volatility across the tested products is different. The negative impact on trade was estimated in groups T0, T4, T7 and T8. These groups represent together 63% of the total turnover of Czech foreign trade. By the contrast, a higher exchange rate volatility is accompanied by an increase in foreign trade turnover in the other product categories. The dominance of product-level trades with indirect relationship between exchange rate volatility and individual tested SITC category translates into a negative coefficient of total trade. Similar results were found on aggregated data by Cociu (2007) using the OLS method. Babecká Kucharčuková (2014) also confirmed the negative effect by using the dynamic and static gravity model. The theoretical assumption of the negative impact of exchange rate volatility on bilateral data was also verified by Šimáková (2014c). For categories T0 and T4 are results consistent with a study by Ferto and Fogarasi (2012), who also confirmed the negative effect of exchange rate volatility on the Czech agri-food trade.

Table 1: Estimated Parametres of Gravity Model of Czechia

	TT	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
Y_d	1.68 ***	2.69 ***	1.22 ***	0.85 ***	1.52 ***	2.10 *	1.92 **	1.53 ***	2.15 ***	1.59 **	3.12 ***
Y_f	0.21 ***	0.11 ***	1.75 ***	1.15 ***	0.52 ***	0.46 ***	1.02 ***	1.15 ***	0.85 ***	1.02 ***	0.12 ***
POP_d	-1.56 **	-2.31	-0.28 ***	-2.15 **	-1.67 **	0.56 ***	0.22 ***	-0.69 ***	1.52 ***	0.85 ***	0.97 *
POP_f	0.37	-0.37 ***	-0.15 ***	-1.02 ***	-0.52	-5.21	1.25	0.54 **	0.56	-0.42	0.26
V(ER)	-0.05 **	-0.52 ***	1.38 ***	1.45 **	0.63 ***	-0.25 **	0.14 *	0.59 ***	-0.45 ***	-0.13 ***	0.12 **
D_{df}	1.39	0.36 ***	0.35 ***	3.88	1.89 *	4.53	-0.96 **	1.25	-1.28 **	-4.02	-2.03
CB_{df}	1.07 *	0.36 ***	0.31	2.75 ***	3.24	3.25	-0.52 *	3.01	2.01	1.03 ***	3.45

*Note: ***, **, * denote significance level at the 1%, 5% and 10% level, respectively.*
Source: authors' calculations

3.2 Results for Hungary

Results for Hungary stated in Table 2 show less statistically significant indicators in comparison to Czechia. In the case of total trade, there are found statistically significant coefficients in accordance with the stated assumptions of the positive effect of GDP growth, population growth and the negative effect of increased exchange rate volatility, or the distances between economic centers. Statistically significant parameters of domestic and foreign income in the product category T5 show that economic growth has a positive effect on foreign trade. In comparison to the Czech Republic, the average estimated impact of domestic income in this analysis is lower than impact of foreign income. The effects of population size for each trade volume are mixed and can not be generalized. Study by Martinez-Zarzosa (2003) states that with the economic growth (here approximated by the GDP and population) can be exported more goods as a result of economies of scale and import more with increasing of product demand. However, the country can export less when the absorption effect prevails and country´s output is consumed by domestic individuals as less products remain for export. Estimated effects for Hungary also shows that common borders or the distance between economic centers in comparison to other parameters do not significantly affect the trade. This fact is probably due to membership of trading partners in the European Union, which provides barier-free trade without significant additional costs for its implementation.

Exchange rate volatility shows in case of total trade statistically significant negative coefficient, what means negative impact on the volume of foreign trade caused by the volatility increasing. However, the results on the product level show that a statistically significance of exchange rate volatility causes reduction of the trades, but this reduction is not as high as evidenced at the overall level. Statistically significant regression of the parameters shows that

the exchange rate volatility leads to a decrease of the group T2, T3, T5 and T6. These groups represent 30.21% of foreign trade activities in the monitored flows. For other categories are not estimated statistical significant coefficient. The results of the study correspond to Cociu (2007) who also estimated the negative effect of exchange rate volatility on the volume of foreign trade at the agregated level through panel regression by using standard deviation to calculate a proxy for the foreign exchange volatility. The standard deviation was also used in the study by Šimáková (2014c) who through the gravity model estimated similar effects at bilateral level. The different results may be found in a study by Ozturk and Kalyoncu (2009). Differences in estimates are attributable to both, the use of different econometric techniques (Engle-Granger cointegration), and also its application to time series data since 1980. The analyzed data include the period durin foreign trade had been influenced more by central planning then the exchange rates.

Table 2: Estimated Parametres of Gravity Model of Hungary

	TT	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
Y_d	0.11 ***	0.16 ***	1.13 ***	-0.06	0.11	0.23	-0.13 ***	0.11 ***	0.16 ***	0.01	-0.47
Y_f	0.25 ***	0.30 ***	0.16	0.58 **	0.51	0.62	0.24 **	0.14 ***	0.41 ***	0.30 ***	-0.04
POP_d	1.24 **	3.02 **	-0.95	1.33	-0.56	1.29	-0.23 *	-0.40 ***	-0.48	-1.18	-1.71
POP_f	-1.85	0.62	-0.41 *	0.59	-1.13	0.33	-0.51	-2.71	1.13	-1.04 **	-0.86
V(ER)	-0.19 **	0.00	-0.01	-0.01 **	-0.00 **	-0.00	-0.01 ***	-0.00 ***	-0.00	-0.00	-0.00
D_{df}	-0.00 *	-0.00	0.00	-0.00 **	0.00	-0.01	0.00	0.00	-0.00	-0.00	-0.16
CB_{df}	-0.00	0.00	0.00	-0.00	0.01	0.00	0.00 **	0.00	0.00	0.00	0.02

*Note: ***, **, * denote significance level at the 1%, 5% and 10% level, respectively.*
Source: authors' calculations

3.3 Results for Poland

Estimated results for Poland are summarized in Table 3. The analysis shows a direct link between the volume of foreign trade and GDP size of the economies involved in the tested foreign trade. One exception is a whole product category T9, whose coefficient of foreign GDP is negative. Poland as an only country (except coefficient T5) has statistically significant coefficients which show the expected effects of population size, population growth and the expanding demand and supply of goods causes increasing of the total volume foreign trade. For product groups T0, T1, T2, T7 and T8 are all statistically significant parameters in accordance with economic assumptions. Product categories representing 44% of the foreign trade of Poland are positively affected by domestic and foreign GDP, by the size of their populations and the existence of the common border. On the other hand, the volume of trade in

these categories decreases with the increase of exchange rate volatility and is also negatively affected by the distance between economic centers of trading partners. In the other product groups, the results within product categories in several ways differ. Product category T9 shows opposite effects of the foreign population and also of the foreign income. Regarding the effects of income (expect product group T2) can be stated that Poland's foreign trade is influenced more by domestic than foreign GDP. Similar results are confirmed in the Czech Republic. Product groups T3 and T4 evidenced positive effect of increasing exchange rate volatility on the volume of realized trade.

Cociu (2007) also demonstrated the negative impact of exchange rate volatility on the Polish foreign trade turnover. Effect of exchange rate volatility in his study compared to other countries is lower. This fact was explained by arguing that small open economies are affected more by the exchange rate volatility. However, when comparing the results of this paper for Poland and Hungary the hypothesis can not be confirmed. The negative impact of exchange rate volatility calculated by the standard deviation for Poland has also been confirmed by using Engle-Granger cointegration in the study Ozturk and Kalyoncu (2009) and using the panel regression model applied by Šimáková (2013b). At sectoral level in the categories of food and agriculture products are results comparable to the study by Ferto and Fogarasi (2012).

Table 3: Estimated Parametres of Gravity Model of Poland

	TT	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
Y_d	0.51 ***	0.48 ***	1.25 ***	0.41 **	0.23 *	1.26 *	1.03 ***	1.26 ***	1.87 ***	1.01 *	0.23
Y_f	0.43 ***	0.30 ***	0.74 **	0.58 **	0.01 **	1.02	0.24 **	0.14 ***	0.41 ***	0.84 ***	-0.04 *
POP_d	2.31 **	1.25 **	-2.03	0.85 **	1.41 ***	0.15 *	0.94 *	0.54 ***	1.23 ***	1.15 **	-0.54
POP_f	1.81 **	2.54 ***	2.34 ***	1.43 **	0.24 *	1.25	-0.01 **	0.15 **	0.82 ***	1.37 **	-0.01 *
V(ER)	-0.52 **	-1.36 ***	-1.99 **	-0.54 **	0.01 **	0.15 **	-0.96 ***	-1.25 ***	-1.00 ***	-0.05 ***	-0.40 **
D_{df}	-0.45 *	-0.25 **	-0.10 ***	-0.05 **	0.10 **	0.01 ***	0.22 ***	-0.71 ***	-0.52 ***	-1.41 ***	-1.96 ***
CB_{df}	1.50 ***	0.96 **	1.52 ***	2.05 ***	3.01 ***	1.63 ***	1.22 **	-0.25 **	1.58 ***	1.42 ***	1.02

*Note: ***, **, * denote significance level at the 1%, 5% and 10% level, respectively.*
Source: authors' calculations

3.4 Results for Slovakia

Estimated parameters derived from a panel regression for Slovakia are reported in Table 4. The product level analysis shows the expected positive impact of GDP on foreign trade turnover of the country. For groups T2, T4, T6 and T9 dominate the effects of foreign income

over the effects of domestic income. Especially in the case of category T6 it is probably due to a significant predominance of export over import of this products. Interesting finding is the fact that the foreign income has approximately the same impact on the trade turnover in all product categories. Estimates of the impact of population size can not be clearly generalized. Theoretical expectations of positive impact of the growth of population size are empirically validated only for product categries T5, T7 and T9, what is consistent with results for Czechia.

Disaggregation to product level further shows that the impact of exchange rate volatility varies across the tested product categories. The negative impact on trade was observed in all product categories except T2, T5 and T9. These groups together represent only 16% of the total turnover of Slovak foreign trade. The fact that a reduction in exchange rate volatility may be reflected in the increased foreign trade turnover is confirmed by the summary indicator of total trade. The same result for aggregated data can be found in paper by Cociu (2007). If we approximate food and agricultural products by category T0, T1 and T4, then the results also correspond with results of a study by Ferto and Fogarasi (2012).

Table 4: Estimated Parametres of Gravity Model of Slovakia

	TT	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
Y_d	1.35 ***	2.04 ***	1.56 ***	0.87 ***	1.52 ***	1.32 ***	2.90 **	1.09 ***	2.26 ***	2.59 **	1.02 ***
Y_f	1.21 ***	1.05 ***	1.22 ***	1.13 ***	1.30 ***	1.36 ***	1.17 ***	1.15 ***	1.22 ***	1.19 ***	1.12 ***
POP_d	0.52 **	-1.05 ***	-0.20 ***	2.05 **	1.67 ***	0.62 **	0.23 ***	-0.68 ***	1.12 ***	0.96 ***	0.93 **
POP_f	0.37 **	-0.37 **	-0.15 **	-1.02 **	-0.52 *	-5.21 *	1.25 *	0.54 **	0.56 **	-0.42 **	0.26 ***
V(ER)	-0.25 ***	-0.72 ***	-0.63 ***	0.15 **	-0.03 ***	-0.24 **	0.17 **	-0.25 ***	-0.16 ***	-0.14 ***	0.12 **
D_{df}	-0.39 ***	0.38 ***	-0.05 ***	-1.78 **	0.59 *	2.09	-0.15 **	1.27 **	-1.26 **	-1.27 **	-3.12
CB_{df}	1.76	0.39 *	4.31	2.63	2.14	1.25	1.63	2.73	1.59	1.68	1.25

*Note: ***, **, * denote significance level at the 1%, 5% and 10% level, respectively.*
Source: authors' calculations

3.5 Discussion of Results for V4 countries

Results of this paper correspond to the existing empirical literature at the aggregated level, which also confirmed the negative effects of exchange rate volatility on V4 foreign trade. Product-level analysis further shows that the impact of exchange rate volatility across the tested product categories can differ. Results show disunity with economic theory in some ways and can not be clearly generalized. Estimated coefficients can be divided in categories with statistically insignificant or economic minimal effects and to categories with important effects. Crude materials, mineral fuels, lubricants and related materials are mostly traded in

the world currencies. This fact translates to the regression coefficients approaching the zero effect of the exchange rate of national currency for the whole Visegrad Four. The world currencies are also used for the trade of transit goods, which entitles roughly the same share of export and import flows. On the other hand, goods produced in a V4 country and afterwards exported to the partner country are affected by exchange rates volatility more significantly, what can be resulted by companies' revenues and expenditures realized in different currencies. Trade with food, live animals, beverages, tobacco and less competitive goods like chemicals and manufactured goods are affected by exchange rate volatility in a positive way as fluctuations in the exchange rate may be used to seize temporary business opportunities. The demand of these goods is more elastic and subsequent delay in exchanging currency to earn a profit.

Ambiguous exchange rate volatility effect on foreign trade which do not verified the economic theory can be explained by several characteristics of V4 participation in international commodity movements. V4 countries have import-intensive exports, the share of imported goods in GDP in 2014 was over 60%, suggesting the economy heavily dependent on imports. Another typical feature is a significant presence of foreign direct investment. Many foreign companies with subsidiary branches in countries surveyed include multinational corporations operating on different territories. This fact implies their strong involvement in export and import transactions within multinational companies.

World economic environment is constantly changing and the current trend of global supply chains and multinational companies is also accompanied by an expansion of the total international trade flows due to intermediate crossing national borders several times during production. In this situation, the relationship between the exchange rate and trade flows can vary significantly. Kiss and Schuszter (2014) also discuss the implications of corporate financing through loans in foreign currencies. All these attributes result in the fact that the bulk of international trade is related to the natural hedging. Čadek et al. (2011) provided such analysis of hedging in case of Czech companies and found that the majority of exports are realized through the euro. The incoming and outgoing payments of foreign trade are carried out without the use of local currency. The paper states that in 2009, almost 60% of Czech exports used natural hedging and the rest was covered mainly by financial derivatives. Similar conclusions can also be found for the other V4 countries in the study by Égert-Zumaquera and Morales (2008). According to Abrams (1980) is a determinant of the relationship and potential export capacity of the country, its structure and consumption, which affects the elasticity of the demand for export and import and, therefore, the effect of exchange rate volatility on trade flows. An important factor in the characteristics of foreign trade V4 is the degree of integration of trading partners. According to Martinez-Zarzoso and Ramos (2008), with the higher integration of economies, the volume of trade between them is increasing and exchange rates as one of the determinants and act to a lower extent. V4 clearly shows the importance of integrity for the implementation of foreign trade and for trade within the EU.

Conclusions

Paper was focused on the relationship between exchange rate volatility and foreign trade. The aim of this paper was to evaluate the effect of exchange rate volatility on the V4 foreign trade on bilateral level as well as on the commodity level for different traded product

categories. Empirical analysis of the effects of foreign currency fluctuations on the foreign trade of the Czech Republic, Hungary, Poland and Slovakia was realized for the period 1999 - 2014. This period represents an environment for analyzing the effects of currency fluctuations on foreign trade in economies based mainly on market principles without government intervention, with floating regime of exchange rates. This work was based on the assumption that the different product categories are characterized by different price elasticity, in every country there are subjects with a variety of consumer and production patterns of behavior and therefore exchange rate uncertainty effects may be different across territorial and product level. Paper provides relatively new insight into the considerations discussed as it represents comprehensive study for the V4 countries provided by relatively new territorial-commodity approach to foreign trade. This paper contributes to the analysis dealing with the post-communist countries, which are fully transformed into a market economy. Conclusions expand the knowledge of empirical studies applied on the V4 region that have been made in the past, mostly for shorter periods of time and on aggregated data. This paper eliminates possible distorted conclusions caused by aggregation of different product categories and countries.

Disaggregating of foreign trade data for each product category shows that the impact of exchange rate volatility across the tested product categories can differ. In the case of Slovakia, a negative effect on foreign trade was identified in all groups except chemicals, raw materials and raw materials for food purposes. For Poland was these effects detected for trade with mineral fuels, lubricants, animal fats, oils and waxes, while other products show their negative effects of exchange rate volatility on international trade. For Hungary, all statistically significant coefficients are negative and thus confirm the assumption of reduction of foreign trade turnover with increased exchange rate volatility. For the Czech Republic, the negative effect of exchange rate volatility was reflected in trade flows of food and live animals, animal and vegetable fats, machinery, transport equipment and miscellaneous manufactured articles. This diversity in estimating of the effects of exchange rate volatility on foreign trade can be found also in the papers relating to the product-level analysis in other countries (e.g. Bahmani-Oskooee and Wang, 2007; Bahmani-Oskooee et al., 2014). This paper provides evidence that the increased exchange rate volatility, which presents a risk for companies operating in international markets, is not clearly translated into decrease of the turnover of the foreign trade.

This paper demonstrates that the exchange rate volatility clearly affects the foreign trade but there is a need to differentiate regional characteristics of the markets where can be placed the production as well as the types of products that will be given for trading in selected foreign markets. The results can be considered by national central banks of V4 countries in assessing the potential impact of the current exchange rate policy. Conclusions can also be used in the creating economic policies to promote foreign trade of specific products.

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Determinants of Regional Entrepreneurial Activity in the Czech Republic

Determinanty podnikatelské aktivity napříč regiony České republiky

ONDŘEJ DVOULETÝ, JAN MAREŠ

Abstract

The following study is focused on analysis of registered businesses in the 14 regions of the Czech Republic during the period of years 1995-2013. The aim of the study was to quantify factors that affect entrepreneurial activity expressed as rate of registered businesses per capita. Based on the previous empirical studies, the determinants were selected and hypothesis stated. Formed hypothesis investigated positive impact of GDP per capita, unemployment rate and R&D institutions on rate of registered business activity. To evaluate them, data were obtained from the Czech Statistical Office and formed into dataset. Firstly, panel regressions estimated with fixed effects method were employed and secondly, Granger causality tests to evaluate the relationship between entrepreneurial activity and GDP per capita were used. Regression estimates proved positive relationship between entrepreneurial activity in Czech regions and GDP per capita, unemployment rate and support activities of R&D institutions. Positive impact was also confirmed for population density, average age, share of tertiary educated population and real R&D expenditures. Testing Granger causality proved dual causality between entrepreneurial activity and GDP per capita confirming that GDP per capita as good predictor of economic development of Czech regions. Finally, economic growth motivates Czech individuals to enter entrepreneurial activity.

Keywords

determinants of entrepreneurship, regional entrepreneurial activity, registered business activity, GDP per capita, unemployment, R&D institutions, the Czech Republic

Abstrakt

Článek je věnován analýze registrované podnikatelské aktivity ve 14 regionech České republiky za období let 1995-2013. Cílem studie je kvantifikovat faktory, které ovlivňují podnikatelskou aktivitu, vyjádřenou jako počet registrovaných subjektů na obyvatele. Na základě předchozích studií byly vybrány determinanty a zformulovány testované hypotézy. Formulované hypotézy očekávaly pozitivní vliv HDP na obyvatele, míry nezaměstnanosti a institucí vědy a výzkumu na registrovanou míru podnikatelské aktivity. K jejich otestování byl použit datový soubor vytvořený z proměnných získaných z databáze Českého statistického úřadu. Nejprve byly odhadnuty modely panelové regrese s fixními efekty, a následně byla testována Grangerova kauzalita pro vztah mezi mírou podnikatelské aktivity v českých krajích a HDP na obyvatele. Regresní odhady potvrdily pozitivní vztah mezi mírou podnikatelské aktivity v českých krajích a HDP na obyvatele, mírou nezaměstnanosti a podpůrnými aktivitami institucí vědy a výzkumu. Pozitivní vliv byl prokázán také pro hustotu obyvatel, průměrný věk, podíl terciárně vzdělané

populace a výdaje na vědu a výzkum. Test Grangerovy kauzality prokázal oboustrannou kauzalitu mezi mírou podnikatelské aktivity a HDP na hlavu, což potvrzuje, že HDP na obyvatele dobře předpovídá budoucí ekonomický vývoj českých regionů. Závěrečným zjištěním bylo, že ekonomický růst motivuje Čechy k zapojení do podnikatelské aktivity.

Klíčová slova
determinanty podnikání, regionální podnikatelská aktivita, registrovaná podnikatelská aktivita, HDP na obyvatele, nezaměstnanost, instituce vědy a výzkumu (R&D), Česká republika

JEL Codes
M2, M1, L260

Introduction

Entrepreneurship was identified as important part of the economy contributing to economic growth measured by country´s GDP (Carree and Thurik, 2010). Positive relationship between entrepreneurial activity and economic growth was also confirmed by Thurik (1995); Berkowitz and DeJong (2005); Van Praag et al. (2007) or Klapper et al. (2015). However there are still authors who argue that those positive effects on GDP and employment vary over time and across countries (Blanchflower, 2000). Carree and Thurik (2010) point out, that there exists dual causality between the entrepreneurial activity and economic growth and encourage scholars to investigate these phenomena on different levels of analysis. Statistical offices and Global Entrepreneurship Monitor reporting entrepreneurial activity allow us to study these kind of relationships in various contexts. Importance of studying entrepreneurship increased with the need to regain competitive advantages after structural changes in modern economies in 21st century.

What are the determining factors having impact on entrepreneurship and how can we increase entrepreneurial activity? Entrepreneurship is cross-disciplinary area, with determinants from psychological, sociological and economical disciplines. Psychology is focused on traits of entrepreneurs and potential entrepreneurs, Sociology on collective background and Economics on impact of economic climate, technological development and demographic trends (Giannetti and Simonov, 2004). The determinants also differ with the level of analysis, which may be conducted on individual (micro), meso (industry or region) or macro (country or group of countries) level (Grilo and Thurik, 2004). Not many studies are focused on regional entrepreneurial activity and therefore research gap on this level exists. On regional level entrepreneurs are perceived as engine of regional development and this level of analysis allows researchers to take into account also geographical and cultural differences (Leitao et al., 2011).

Based on Global Entrepreneurship Monitor, in 2013 on average 5.3% of Czech adult population was engaged into established entrepreneurial activity (Lukeš et al., 2014). We have investigated previous empirical studies and conclude that there are not many studies dedicated to determinants of entrepreneurship in relation to all regions of the Czech Republic, and that none of the scholars tested the relationship between the entrepreneurial activity and economic growth in both directions using more robust econometric approach. Our analysis is conducted from economic perspective and serves as complement to already

published research studies focused on the Czech entrepreneurial activity which are also in this paper presented.

In the first (theoretical) part we introduce previous studies devoted to determinants of entrepreneurial activity and develop tested hypothesis. Second part describes collected variables for the analysed period of years 1995 - 2013 and third section employs econometric models to fulfil our research aim, identification of the main factors having impact on entrepreneurial activity in the regions of the Czech Republic. Finally, Granger Causality test deals up with the dual causality between the entrepreneurial activity and GDP per capita. Main findings, limitations of our approach and suggestions for future research are summarized in conclusions

1 Theoretical Background

Coleman (1988) explains that every entrepreneur needs to be equipped with resources, which include physical, financial, human and socio-cultural capital. It has been stated by Gartner (1985) that venture creation is a multi-dimensional phenomenon and should be looked upon with all the complexities. Sandberg and Hofer (1988) mention that performance of a newly established venture is influenced by the structure of the industry, where the business operates, its organisational structure and strategy. Stuart and Sorenson (2003) perceive the geographical location of newly established venture as a key determinant of success as some areas have better infrastructure and access to resources. Besides all forms capital, entrepreneur needs to have certain level of self-confidence, willpower and ability to build networks.

Entrepreneurs typically build networks in the region where they are involved in their activity, and hence their ability to succeed in networking may be affected by regional characteristics. As remarks Karlsson et al. (1993), business environment consists of all relevant socio, economic and cultural variables. Differences in regional entrepreneurial activity may be described by four models (market model, resource model, milieu model and career model). Karlsson et al. (1993) proved positive relationship between newly established entrepreneurial activity per thousands of households and GDP per capita, population with tertiary education, public expenses for regional development and share of economically active population.

Grilo and Thurik (2004) divide determinants of entrepreneurship into supply and demand side. The supply side is determined by population characteristics, such as size, growth, age structure, population density and share of immigrants. Economic development, globalization and stage of technological development are considered as demand side of entrepreneurship. They also explain that once the overall economic performance is declining, the wages and salaries are declining and the entrepreneurial activity decreases. On the other hand, the increase in unemployment rate force individuals to create jobs for themselves by engaging into entrepreneurial activity, so there are two effects acting against each other and it is important to analyse, which exceeds. This varies among countries and time period. The main finding of Grilo and Thurik (2004) was that lack of financial resources does not have impact on entrepreneurial activity. Secondly, they find that administrative barriers negatively influence entrepreneurial engagement. They also stress that for the most of the included variables we can observe ambiguous impact on entrepreneurial activity.

Wennekers et al. (2005) worked with Global Entrepreneurship Monitor and used as explanatory variables GDP per capita for economic variables and education (tertiary and secondary) as demographic. They present positive effect of income and education on entrepreneurial activity. Freytag and Thurik (2007) analysed the role of cultural variables on entrepreneurial aspirations. As cultural variables they used proxy variables social spending, regulations (barriers), political and other organizations, economic freedom index and life expectancy index. Life expectancy, social and health expenditures confirmed negative impact on preferences towards entrepreneurship. Index of economic freedom had positive impact on entrepreneurial aspirations.

Roig-Tierno et al. (2015) stress the importance of supportive infrastructure, such as business incubators, technology centres and universities. Regarding to their research, supportive infrastructure have the highest impact on innovative entrepreneurship. The aim of these institutions is to boost innovative activity and commercialize it as a product or service. Business sector has therefore interest to establish networks with these R&D institutions, which act with each other complementarily. Roig-Tierno et al. (2015) found positive effects on employment creation. Also investments into R&D create scientific knowledge and therefore new entrepreneurial opportunities. These opportunities are exploited by entrepreneurs who commercialize them and therefore the entrepreneurial activity increases (Sanders, 2007). Grilo and Thurik, (2004) also support this argument stating that R&D investments support technological advancements and stimulate entrepreneurial activity.

Currently, scholars in determinants go back to investigation of relationship between entrepreneurial activity, unemployment and GDP per capita, since there are more counter effects at the same time. When unemployment is high, unemployed individuals may choose to become entrepreneurs and enter the market introducing a new technological innovation since they need to make income for living. (Llopis et al., 2015). Positive relationship between entrepreneurship, quantified as rate of new business registrations, and unemployment rate confirmed by Fritsch et al. (2015). However, Cueto et al. (2015) argue that positive relationship between unemployment rate and entrepreneurship occurs only when unemployment increases substantially. Koellinger and Thurik (2012) conclude that increase in entrepreneurial activity was associated with the increase of GDP and decrease of unemployment. They also found that future trends in entrepreneurship help to predict economic fluctuations using Granger tests of causality, VAR models and fixed effects regression estimations. On the other hand economic growth stimulates creation of new opportunities and leads to increase in entrepreneurial activity. Authors conclude, that it is important to use lags, some effects may take several years to occur. In their models, they use two years lag. Klapper et al. (2015) also proved positive, pro-cyclical relationship between GDP per capita and entrepreneurial activity. However those relationships vary over time and need to be analysed over time and across countries (Llopis et al., 2015).

Entrepreneurial activity in the Czech Republic is most frequently investigated by researchers from micro and meso level perspective, mostly surveying individual entrepreneurs and managers of companies. Lukeš et al. (2014) conducted Global Entrepreneurship Monitor in 2013 for the Czech Republic and conclude that on average 7.3% of adult population aged 18-64 years was actively involved in setting up business and on average 5.3% of adult popula-

tion was running established business.[1] According to interviewed entrepreneurs, the biggest problems in business activity are lack of contracts, administrative barriers, bureaucracy, frequent changes in laws and chaotic system of taxation. Strýčková (2015) conducted research focused on determinants of capital structure of Czech enterprises and concludes that key external factors of capital structure were economic and political development, market environment and levels of taxes and interest rates. Small business enterprises (SMEs) in selected regions of the Czech Republic and Slovakia were investigated by Belás et al. (2015). According to their findings the most important motive for starting a business in the Czech Republic was to have a job. In Slovakia, the most important motive for starting a business was money. Belás et al. (2015) confirmed that Czech business environment is affected by relatively high level of corruption and also that Czech entrepreneurs are perceived on public still negatively. Role of state was by surveyed entrepreneurs perceived negatively, highlighting creation of meaningless barriers and obstacles. These results of entrepreneurial perceptions are also described by World Economic Forum (2016) reporting the most problematic factors for doing business in the Czech Republic. The most problematic factors are inefficient government bureaucracy, corruption, policy instability, complexity of tax regulations and restrictive labour regulations (World Economic Forum, 2016).

Despite increasing research interest in the Czech entrepreneurship, studies focused on determinants of population of active enterprises, using previously introduced methodology, conducted on macro (country) level, are still very limited. One of the recent attempts to study registered business activity on country level was conducted by Menčlová (2014) for period of years 1992 - 2011 using only bivariate correlation analysis to investigate relationship between entrepreneurial activity, unemployment rate and GDP growth. Menčlová (2014) was unable to prove statistically significant relationship with GDP on level base. Some relationship was proved for the GDP growth lagged by one year for newly registered companies with more than 20 employees. For the unemployment rate, negative correlation coefficient was statistically proved for joint-stock companies and companies with limited liabilities. Menčlová (2014) did not find any empirical support for impact of economic recession in 2009 on entrepreneurial activity. However study using more robust econometric approach investigating whole population of the Czech active enterprises applied by Koellinger and Thurik (2012) is still missing and allowing us to fill in this research gap by its implementation in the Czech environment. The next session informs reader about our methodological approach and tested hypothesis.

Method and Tested Hypothesis

Based on the theoretical background and methodology applied by previous authors (Koellinger and Thurik, 2012) we developed following hypothesis that are tested:

H_1: There is a positive relationship between entrepreneurial activity and GDP per capita.
H_2: There is a positive relationship between entrepreneurial activity and unemployment rate.
H_3: There is a positive relationship between entrepreneurial activity and R&D institutions.
H_4: Entrepreneurial activity predicts the economic development.

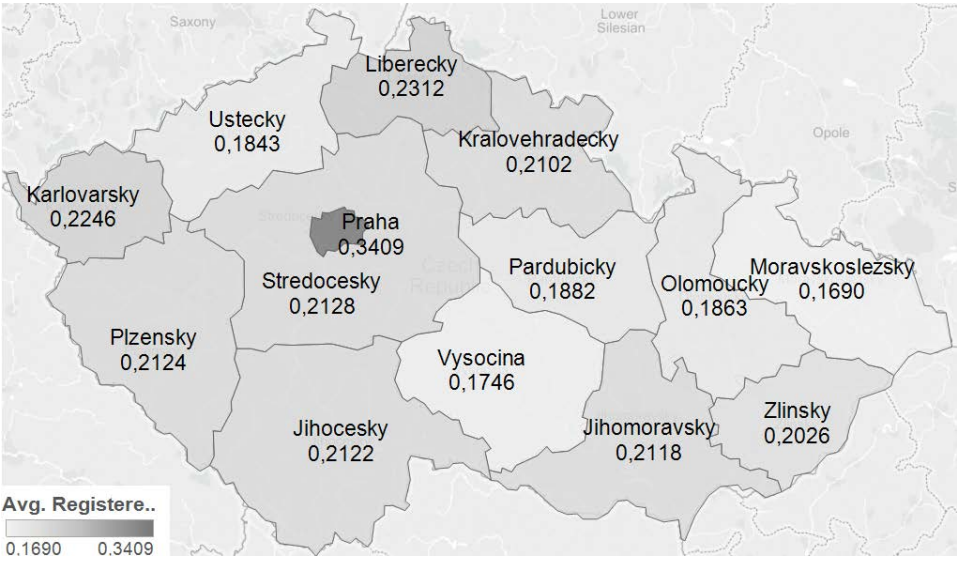
1 *Running business for more than 42 months and paying salaries or wages to its owners (Lukeš et al., 2014).*

To confirm/reject the hypothesis we use econometric approach based on collected data. For the first three hypotheses **(H_1-H_3)** we construct regression models with lagged variables (with impact up to two years lag) and for the fourth hypothesis **(H_4)** we employ Granger causality test. The next part is dedicated to introduction of the dataset.

2 Data

Data were obtained from different parts of Czech Statistical Office database (ČSÚ, 2015) and formed into a panel of 14 regions of the Czech Republic for period of years 1995-2013. Unfortunately not all variables mentioned in previous studies were available for our analysis so we tried to obtain as many relevant variables as possible and for the longest available period. The dependent variable was set up as amount of registered businesses per capita *(REG_BUSINESSES_CAP)*, representing entrepreneurial activity. It would be most appropriate to have entrepreneurial activity obtained from population survey like Global Entrepreneurship Monitor, however such a data are still not available for longer time period. There are two limitations following this approach, firstly as mention Koellinger and Thurik (2012) we do not have covered early stages of entrepreneurial activity and secondly, there are businesses which are officially registered but not in reality active. Taking this limitation we are allowed to compare regions of the Czech Republic in panel regression.

Figure 1: Average registered business activity in Czech regions[2] during years 1995-2013

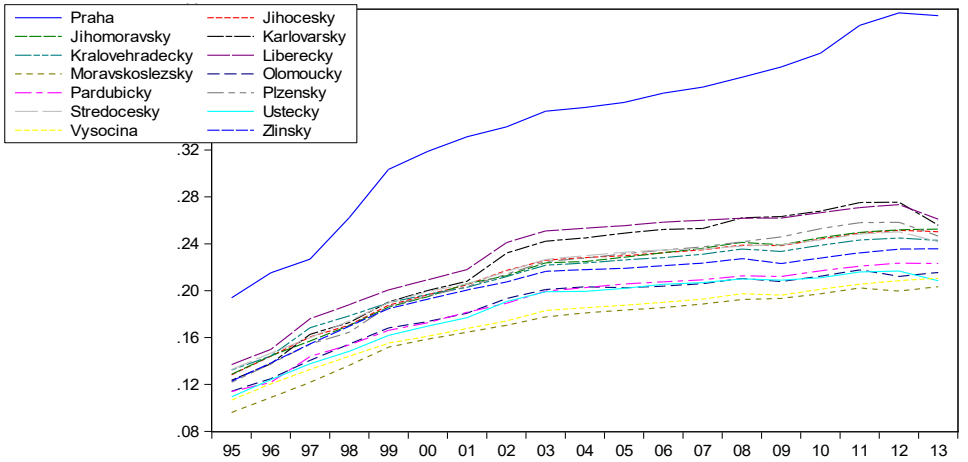


Source: Tableau, own elaboration.

2 *English equivalent names of the Czech regions: Praha - Prague, Stredocesky - Central Bohemia, Jihocesky - South Bohemia, Plzensky - Plzen, Karlovarsky - Karlovy Vary, Ustecky - Usti nad Labem, Liberecky - Liberec, Kralovehradecky - Hradec Kralove, Pardubicky - Pardubice, Olomoucky - Olomouc, Moravskoslezsky - Moravia-Silesian, Jihomoravsky - South Moravia, Zlinsky - Zlin, Vysocina - Vysocina.*

On Figure 1 we have plotted average entrepreneurial activity based upon our calculations during years 1995-2013. As expected the highest rate of registered businesses is in the Capital Praha which may affect results of regression analysis as outlier, so we notice that for validity of regression models. The lowest level of entrepreneurial activity was found in Moravskoslezsky region. The difference between registered business activity in 1995 and 2013 are depicted on Figure 3 in Appendix. Over the analysed period, in all regions total entrepreneurial activity significantly increased as can be seen on Figure 2.

Figure 2: Rate of Registered Businesses per Capita over years in Czech regions



Source: EViews, own elaboration.

Among explanatory variables we were able to collect for all regions average age of population (AVERAGE_AGE), where we assume positive sign, since entrepreneurial activity requires collecting resources. For unemployment rate *(UNEMPLOYMENT_RATE)* we expect positive sign since during higher levels of unemployment people switch from unemployment into self-employment. Business enterprise R&D expenditures in mil. CZK is calculated per capita *(REAL_EXP_RD_CAPITA)* and we assume that support of R&D will stimulate technological and innovation driven businesses. For GDP per capita in CZK *(REAL_GDP_PER_CAPITA)* we expected also positive sign as indicator of increasing economic performance of economy motivating individuals to engage into entrepreneurship (pro-cyclical relationship). Number of Business enterprise workplaces (subjects mainly focused on R&D) in responding units per thousands of inhabitants *(WORKPLACES_RD_THINH)* as variable representing of supportive infrastructure (positive sign). Share of economically active population between 15 and 64 years (*SHARE_PUPULATION_1564)* as factor for supply side of entrepreneurship together with population density *(POPULATION_DENSITY)* positively affecting entrepreneurship. Share of population obtaining tertiary education for demographic variable and resource model *(TERTIARY_EDUCATION)* positively affecting registered businesses per capita. GDP per capita and business enterprise R&D expenditures had to be converted into real variables using Consumer Price Index (CPI) with base year 2005. Unfortunately data for variables representing R&D workplaces and real R&D expenditures of business enterprises were available only for period of years 2005-2013. Descriptive statistics for all variables are presented in Table 1.

Table 1: Descriptive Statistics

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
AVERAGE_AGE	39.49	39.67	42.03	36.00	1.50	266
REG_BUSINESSES_CAP	0.21	0.21	0.44	0.10	0.06	266
UNEMPLOYMENT_RATE	6.71	6.32	15.97	1.90	2.87	266
REAL_EXP_RD_CAPITA	0.002	0.002	0.008	0.0002	0.001	126
REAL_GDP_PER_CAPITA	276369.2	249999.7	766349.1	194983.4	100161.7	266
WORKPLACES_RD_THINH	0.21	0.18	0.55	0.05	0.11	126
SHARE_POPULATION_1564	0.70	0.70	0.72	0.67	0.01	266
POPULATION_DENSITY	287.74	118.23	2533.92	62.11	597.60	265
TERTIARY_EDUCATION	10.55	10.39	21.72	4.81	2.79	266

Source: EViews, own elaboration.

2.1 Stationarity

We are working with panel data which are combination of time series and cross sections. From 1980s econometricians wrote articles about estimation of econometric models on non-stationary data that led into so called spurious regression giving misleading results. Stationarity is tested using joint Dickey-Fuller test for all regions of the Czech Republic. The null hypothesis states non-stationarity of the variable (existence of unit root). By rejecting the null hypothesis, we are able to accept alternative hypothesis of stationarity of the variable (Verbeek, 2012). All variables were tested for stationarity and for all of them we were able to reject the null hypothesis of non-stationarity on 5% level of statistical significance and conclude that we are working with stationary data (results are presented in Table 2).

Table 2: Stationarity Testing Results

Variable	Stat. Significance	P-Value	Result
AVERAGE_AGE	5%	0.00	Stationary
POPULATION_DENSITY	5%	0.049	Stationary
REAL_EXP_RD_CAPITA	5%	0.05	Stationary
REAL_GDP_PER_CAPITA	5%	0.001	Stationary
REG_BUSINESSES_CAP	5%	0.00	Stationary
SHARE_POPULATION_1564	5%	0.00	Stationary
UNEMPLOYMENT_RATE	5%	0.00	Stationary
TERTIARY_EDUCATION	5%	0.00	Stationary
WORKPLACES_RD_THINH	5%	0.03	Stationary

Source: EViews, own elaboration.

3 Regression Analysis

For quantification of the relationships among variables, regression analysis is employed. All econometric models were estimated using software EViews 8. As we mentioned before, the aim of regression analysis is to investigate, which factors affect rate of registered businesses in the Czech Republic and evaluate stated hypothesis from section Method and Tested Hypothesis.

3.1 Estimation of Econometric Models

Firstly we had to choose suitable estimation technique. Usually for legal entities, fixed effects estimation is used, because those entities remain the very same over the time. To support our expectations, we used Hausman test which helps us to decide between estimation with fixed and random effects. Hausman test confirmed for our data estimation with fixed effects that helps us to control unobserved heterogeneity in our models (Verbeek, 2012). Then the econometric models were estimated with fixed effects and White cross-section standard errors & covariance (d.f. corrected) which helps us to avoid consequences of heteroscedasticity and autocorrelation. In all regression estimates we controlled the level of multicollinearity and also checked the normality of residuals. Unfortunately, some of our models violate assumption of normality of residuals which restrict our options to generalize results on other states and regions. Estimated models are depicted in Table 3.

Models 1 and 2 covered whole period, however, for the variables R&D workplaces and real R&D expenditures we did not have observations for the whole period so they were estimated separately (Models 3 and 4 in Table 3). R&D variables highly correlated with real GDP per capita, so in those models, the variable representing real GDP per capita had to be excluded to satisfy assumption of acceptable level of collinearity tested using Variance Inflation Factors test. Collinearity problems also occurred between unemployment rate and share of tertiary educated population. Therefore we estimated two models with unemployment rate and two models with tertiary education, to satisfy acceptable level of collinearity in regression models. To make sure that region Praha does not bias the results of the regressions the presented models were estimated without this region, however results of estimated reduced regressions brought us the same results so finally region Praha was kept in the final models. The following section interprets results of regression analysis.

3.2 Results and Discussion

Before interpreting individual explanatory variables, we conclude that our constructed models have high explanatory power of the dependent variable represented by the rate of registered business activity in the Czech regions. The most contributing variables explaining variety in business activity were share of tertiary education, GDP per capita and unemployment rate explaining majority of the variability of the dependent variable. In the first model (Model 1) we found empirical support for positive impact of GDP per capita ceteris paribus, mirroring economic situation of the Czech regions. All variables in the first model were found to be statistically significant at least on 10% level of statistical significance. These results are not in agreement with sign obtained by Menčlová (2014), however are in consistency with previous researchers using similar methodology, such as Koellinger and Thurik (2012) or Klapper et al. (2015). We support obtained positive signs of coefficients by explanation that

new opportunities reveal, once the economy grows and therefore people are motivated to create ventures (entrepreneurship driven by opportunities).

Positive sign was obtained also for the variables representing population density, average age and share of tertiary educated population offering explanation that Czech entrepreneurs engage more into business creation once they obtain relevant amount of experience, networks and education, resource based view on entrepreneurship, which was described by Wennekers et al. (2005). Increase in population density leads to higher volume of interactions among economic agents and increase in networking which is according to previous research (Stuart and Sorenson, 2003) positively associated with entrepreneurial activity. The positive sign of average age may be interpreted as proxy variable for increase in experience of population which could be used for engagement into business activity. More educated individuals are able to implement and commercialize outputs of scientific research. Unfortunately, estimated econometric models did not agree on the impact of share of economically active population providing contradictory signs, therefore this question is still open for future research.

Variable representing economic crisis during years 2008-2010 revealed that in comparison with other periods, entrepreneurial activity was during years 2008-2010 higher. Positive response of entrepreneurial activity towards significant increase in unemployment rate during economic recessions was described by Cueto et al. (2015). Second model (Model 2) was focused on the impact of unemployment rate. The variable representing unemployment rate was included in level form, first lag and second lag. Despite the fact, that first lag was not found to be statistically significant, all coefficients were positive, again contrary to the findings obtained by Menčlová (2014), but in accordance with positive sign reported by Fritsch et al. (2015) or Belás et al. (2015) who argue that the most frequent motivation of the Czech entrepreneurs for entering business activity was to have a job. Therefore increase in unemployment rate was associated with higher engagement of Czech economic agents into entrepreneurship (becoming self employed or setting up a new enterprises) covered by theory of necessity entrepreneurship.

Third and fourth model (Model 3 and Model 4) were estimated only for period years 2005 - 2013 because of lack of the data depicting R&D sector. The models supported previously introduced positive signs of coefficients for population density, average age, tertiary education and unemployment rate. Model 3 tested the impact of R&D workplaces on registered business activity. The results confirmed positive impact of research institutions on business activity through improving socio-cultural networks and supportive activities mentioned by Roig-Tierno et al. (2015). The last econometric model (Model 4) tested the impact of real R&D expenditures on entrepreneurial activity and both estimated coefficients were positive. However, only coefficient of R&D expenditures lagged by one year was found to be statistically significant. This result may be explained by delays caused by distribution of new scientific knowledge towards entrepreneurs and potential entrepreneurs and by time required for transferring knowledge into product or service. Positive impact of R&D expenditures was also obtained by (Sanders, 2007).

Summing up results of regression estimates we are able to accept first three hypotheses stating that there exists positive relationship between entrepreneurial activity in the Czech regions and GDP per capita, unemployment rate and support activities of R&D institutions. Hypothesis $\mathbf{H_1}$, $\mathbf{H_2}$ and $\mathbf{H_3}$ are accepted.

Table 3: Model Table

Variable / Model	Model 1	Model 2	Model 3	Model 4
Dependent Variable:	*REGISTERED_BUSINESSES_PER_CAPITA*			
CONSTANT	**0.002249***	**-1.174835*****	**-0.017757*****	**-0.169627**
	0.001207	0.118169	0.000995	0.207964
REAL_GDP_PER_CAPITA	**3.02E-09*****			
	3.64E-10			
POPULATION_DENSITY	**3.94E-06*****	**0.000525*****	**4.56E-06*****	
	5.22E-07	9.78E-05	8.74E-07	
AVERAGE_AGE	**0.000174*****	**0.020583*****	**0.000341*****	**0.008861***
	1.88E-05	0.000807	2.33E-05	0.005175
SHARE_POPULATION _1564	**-0.017400*****	**0.582044*****		
	0.001157	0.127560		
UNEMPLOYMENT_RATE		**0.001276*****		**0.000398**
		0.000491		0.001612
UNEMPLOYMENT_RATE (-1)		**0.000453**		
		0.000626		
UNEMPLOYMENT_RATE (-2)		**0.001045***		
		0.000592		
TERTIARY_EDUCATION	**0.020021*****		**0.020272*****	
	4.75E-05		2.13E-05	
TERTIARY_EDUCATION (-1)	**0.000131*****			
	3.41E-05			
ECONOMIC_CRISIS	**0.000144*****			
	2.36E-05			
WORKPLACES_RD_THINH			**0.000668****	
			0.000319	
WORKPLACES_RD_THINH (-1)			**0.001126*****	
			0.000356	
REAL_EXP_RD_CAPITA				**7.730759**
				7.360853
REAL_EXP_RD_CAPITA (-1)				**16.96424****
				7.661041
R-squared	0.999998	0.952742	0.999998	0.582432
Adj. R-squared	0.999997	0.948604	0.999998	0.566822
F-statistic	4687862.	230.2530	3143024.	37.31144
Observations	251	237	111	112

Note: Standard Errors are in parenthesis, *** stat. significance on 1 %,
** stat. significance on 5 %, * stat. significance on 10 %.

Source: EViews, own elaboration.

4 Entrepreneurship and Economic Growth – Dual Causality

This part tests the relationship between entrepreneurial activity and GDP per capita in the sense of Granger causality evaluation, testing to what extend are variables able to predict future values based on their previous values. The null hypothesis states that there is no Granger-Causality between tested variables, by rejecting it we are allowed to accept alternative hypothesis of existence of such relationship (Granger, 1969). Results of the tests are reported in Table 4. On 5% level of statistical significance we are able to reject the null hypothesis and accept the alternative. This result was controlled also using lags 2 and 5 obtaining the same result. GDP per capita Granger causes entrepreneurial activity and also, entrepreneurial activity Granger causes GDP per capita which is in agreement with results obtained by Koellinger and Thurik (2012). We verify $\mathbf{H_4}$ that entrepreneurial activity predicts the economic development of the Czech regions. Arguing that firstly, economic growth motivates additional individuals to engage into entrepreneurial activity, however also, entrepreneurial activity is good predictor of economic development of the Czech regions.

Table 4: Granger Causality between Entrepreneurship and Economic Growth

Tested Relationship	P-value	Lags	H0 Reject
REAL_GDP_PER_CAPITA ➔ *REGISTERED_BUSINESSES_PER_CAPITA*	0.00	10	Rejected
REGISTERED_BUSINESSES_PER_CAPITA ➔ *REAL_GDP_PER_CAPITA*	0.00	10	Rejected

Source: EViews, own elaboration.

Conclusions

This paper aimed to investigate relationship between the rates of registered businesses in the fourteen regions of the Czech Republic during period of years 1995-2013. Following previous studies, existing models explaining differences in regional business activity were discussed. We also introduced empirical findings of previous scholars and variables they suggest to take into account when determining factors having impact on entrepreneurial activity. Based on the previous research studies we developed four hypotheses which were tested in the empirical part of the article. Dataset was created based on variables collected from the Czech Statistical Office. Firstly we estimated econometric models using fixed effects method approach with lags to determine variables having impact on entrepreneurial activity. We were able to accept the hypothesis assuming positive relationship between entrepreneurial activity in the Czech regions and GDP per capita, unemployment rate and support activities of R&D institutions. This leads to main conclusion that during times of higher unemployment rate Czech people become self employed or set up their own business to earn income. Positive impact was also confirmed for population density, average age, and share of tertiary educated population supporting resource based view when explaining diversity among regional entrepreneurial engagement. Increase in real R&D expenditures suggested positive impact on entrepreneurial activity. The second part

of empirical analysis tested the relationship between GDP per capita and entrepreneurial activity using Granger causality test. Dual causality was statistically confirmed, so entrepreneurial activity is a good predictor of economic development of the Czech regions and on the other hand, economic growth motivates additional individuals to engage into entrepreneurial activity by bringing new business opportunities.

However, presented results have also several limitations that must be taken into account. First of them is related to operationalization of entrepreneurial activity expressed as rate of registered businesses in the Czech regions. The number of registered business may be in reality higher in comparison with real active enterprises for two reasons. Firstly, in the economy, there are businesses that are officially registered, however they are not active anymore, and secondly, some of registered entrepreneurs are in reality employees working under schwarz system conditions. On the other hand, in the registered business activity are not covered early stages of entrepreneurial activity, such as nascent entrepreneurship. Therefore it will be beneficial to operationalize entrepreneurial activity in a different way, such as based on population surveys (Global Entrepreneurship Monitor) to check our results. Unfortunately, data from population surveys so far do not cover even national entrepreneurial activity in sufficiently long time series nor on regional level. Also, more frequent data than annual, such as quarterly or monthly will be necessary to provide deeper insight into determinants of the Czech entrepreneurship. Since we were able to collect only data for period of years 1993-2013, we need to wait until updated data will be published to be able to increase our research sample. More frequent data and larger data set allow to implement more sophisticated econometric techniques, such as Vector Autoregressive models (VAR) and construction of impulse response functions.

As for policy recommendation, we suggest entrepreneurial policy makers to be prepared to organize entrepreneurial education, such as trainings and workshops, and allocate more resources towards entrepreneurial infrastructure, such as science parks and business incubators, to support current, potential and new entrepreneurs during times of higher unemployment rate that was already mentioned for example by Lukeš et al. (2014). We further encourage any initiatives trying to monitor entrepreneurial activity and recommend allocation of resources towards more detailed monitoring of the Czech entrepreneurship. Finally in our research we made no difference between various types of entrepreneurial activity. Business companies and self-employed individuals have its specific characteristics and therefore their determinants may differ. Studies investigating them separately should become a challenge for future researchers. More determinants of the Czech regional entrepreneurial activity should also be tested, we suggest to investigate the impact of share of immigrant population, share of economically active population, regional corruption perceptions or regional entrepreneurial subsidies.

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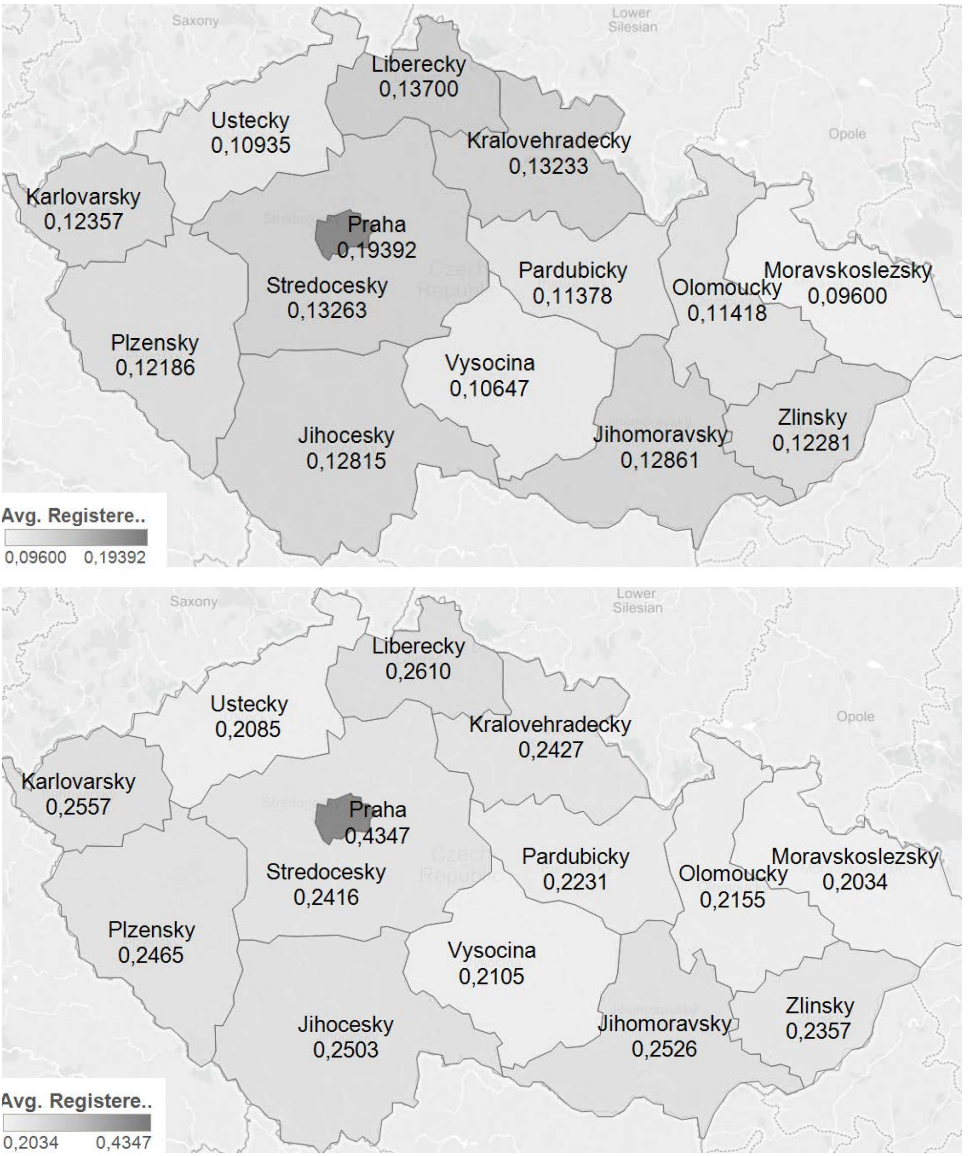
Appendix

Figure 3: Registered business activity in the Czech regions in 1995 (top) and 2013 (bottom)



Source: Tableau, own elaboration.

Economic and Legal Aspects of Electronic Money

Ekonomické a právní aspekty elektronických peněz

OTAKAR SCHLOSSBERGER

Abstract

The term "electronic money" first appeared in Czech legislation in 2002 as the result of the transposition of legislation into the Czech Republic's legal system in anticipation of the country's accession to the European Union. This term subsequently reappeared in 2009 during the recodification of the legal regulation of payment services, payment systems and electronic money. At this time, the definition was subjected to certain changes which continue to exert a significant influence on current practice with respect to the issuance and subsequent use of electronic money. This paper addresses the term "virtual money" and considers the mutual relationships between "electronic money", "cashless money" and "virtual money" from the point of view of selected legal and economic approaches. The aim of the paper is to employ the analytical method in order to investigate selected legal and economic aspects of the various interpretations of the categories "electronic money", "cashless money" and "virtual money". A comparative analysis approach will be applied so as to ascertain both the legal and economic differences between these categories and general conclusions will be suggested employing the deduction method. The article is further concerned with the influence of these categories on the monetary base and money supply indicators.

Keywords

electronic money, virtual money, issuer of electronic money, payment card, regulation, emission, monetary base, money supply

Abstrakt

V českém právním řádu se objevil pojem „elektronické peníze" poprvé v roce 2002. Jednalo se o kategorii, která byla do právního řádu České republiky transponována v souvislosti s přípravou České republiky na vstup do Evropské unie. Následně se tento pojem znovu objevil v roce 2009 při rekodifikaci právní úpravy platebních služeb, platebních systémů a elektronických peněz. Při této příležitosti došlo k tomu, že kategorie doznala určitých změn, které však mohou mít značný vliv na současnou praxi při vydávání a následném využívání elektronických peněz. Stať se mj. také dotkne pojmu „virtuální peníze" a bude se zamýšlet nad vzájemným vztahem „elektronických peněz", „bezhotovostních peněz" a „virtuálních peněz", a to z pohledu vybraných právních a ekonomických přístupů. Cílem příspěvku je pomocí metody analýzy interpretovat vybrané právní a ekonomické aspekty různých přístupů ke kategoriím „elektronické peníze", „bezhotovostní peníze" a „virtuální peníze". Komparativní analýzou budou zjištěny jak právní, tak ekonomické rozdíly mezi těmito kategoriemi a metodou dedukce definovány obecné závěry. Stať se zabývá vlivem těchto kategorií na ukazatel měnové báze a peněžní zásoby.

Klíčová slova
elektronické peníze, virtuální peníze, vydavatel elektronických peněz, platební karta, regulace, emise, měnová báze, peněžní zásoba

JEL Codes
E42, G23

Introduction

Electronic money as a category first appeared in Czech legislation in Act No. 124/2002 Coll., on the Transfer of Financial Means, Electronic Payment Tools and Payment Systems (the Act on Payment Systems, hereinafter referred to as "APS 2002"). The APS 2002 consisted of the transposition of several European Union (hereinafter referred to as the "EU") directives into Czech legislation in anticipation of the Czech Republic (hereinafter referred to as the "CR") acceding to the EU, and aimed at the harmonisation of selected services in the areas of payment systems and accounting within EU countries. The collection of directives included Directive of the European Parliament and of the Council 2000/46/EC dated 18 September 2000 on the taking up, pursuit of and prudential supervision of the business of electronic money institutions (hereinafter referred to as "Directive 2000"). Provisions § 14 to 22 of APS 2002 addressed the issue and use of electronic payment tools, provided a definition of electronic money and electronic payment tools and, for the first time, laid down a legal definition of those authorised to issue electronic money, i.e. so-called electronic money institutions. This essay intends to focus on the category of "electronic money" only (without reference to the other new legal terms introduced in APS 2002) and aims to provide an economic and legal analysis of the categories "electronic money" and "virtual money" as well as a detailed comparison of the definitions thereof. The essay will then go on to provide the author's opinions concerning the potential related practical impacts.

The descriptive method was used in the compilation of this paper with reference to the terms "electronic money", "cashless money" and "virtual money", whereas the comparative method was used for the purpose of their mutual comparison. The links between cashless, electronic and virtual money and the monetary base and money supply were subsequently investigated as indicators which might be influenced by the issuing of electronic and digital money. General conclusions with respect to the various economic and legal aspects were then defined on the basis of comparative analysis employing the deduction method.

It is anticipated that the contribution of the paper will be seen in the light of the connection between the legal and economic aspects issuing from the influence of electronic, cashless and digital money in the areas monitored.

1 The Term "Electronic Money"

A comparison of APS 2002 and Directive 2000 reveals that the term "electronic money" stems from the Directive with, nevertheless, a number of small differences. Article I para. 3 letter b specifies that "electronic money" refers to cash value expressed as a claim on the issuing institution which is:

a) stored within an electronic medium;
b) issued against the receipt of a financial sum, the value of which shall not be lower than the issued cash value;
c) received as a payment tool by institutions other than the issuing institution.[1]

APS 2002 defines electronic money as follows:

Electronic money is a cash value that:

a) represents a claim on the issuer,
b) is stored within an electronic financial tool,
c) is issued against the receipt of a financial sum with a lower value than that of the electronic money issued and
d) is accepted as a payment tool by persons other than the issuer.[2]

Beyond the terms of Directive 2000, APS 2002 in provision § 15 para. 2 defined an electronic payment tool as "a payment tool" that maintains the cash value in an electronic form.

By means of a simple comparison of the texts of Directive 2000 and APS 2002 it is evident that the harmonisation norm emphasises in its list of provisions "a claim on the issuer" as a separate condition. This requirement in fact appears logical in terms of the nature of electronic money and the issuance thereof.[3] There is a clear difference in terms of the provision relating to maintaining the value of electronic money. The Directive specifies that the value of the financial sum involved must be maintained when using an electronic medium; the APS 2002 version, however, refers to maintaining the value within an electronic financial tool. The difference in this criterion is important in terms of practical significance. Electronic financial tool refers to e.g. the so-called electronic wallet, i.e. a type of "payment card" featuring an electronic record on the specific amount of electronic money contained within the body of the electronic financial tool, i.e. a data medium that, at first sight, appears the same as a standard payment card. The focus of the provision of Directive 2000 on the other hand is more general in that an electronic medium refers to a magnetic or chip entry on any data medium that is capable of functioning as "an electronic financial tool"; nevertheless, it might also be regarded as the "computer memory" or "computer server".

Notwithstanding, it can be stated that APS 2002 clearly defines the characteristics of electronic money which is applicable both in practical terms and with concern to the theory

1 *A quotation from Directive of the European Parliament and the Council 2000/46/ES dated 18 September 2000 on the taking up, pursuit of and prudential supervision of the business of electronic money institutions.*

2 *A quotation from Act No. 124/2002Coll., on the transfer of financial means, electronic payment tools and payment systems (Act on payment systems, § 15 para. 3, as amended) indicating that the original characteristics included provisions specifying only that "electronic money is a cash value maintained within an electronic financial tool".*

3 *Electronic money can be issued only against the receipt of cash or its transformation from cashless money, i.e. by transfer at the suggestion of the holder of electronic money to its issuer from the current or payment account of the holder to the registered "bank subaccount" of the issuer of electronic money. No form of issue (e.g. fiduciary) is permissible.*

of payment systems. Theory concerning banking as outlined in various literature sources[4] unequivocally adopted those characteristics of electronic money as defined in APS 2002. However, it is important to point out that the relevant sources failed to address electronic money as an alternative form of money. Theoretical literature continued to classify forms of money as simply "cash" and "cashless". The afore-mentioned characteristics, however, clearly defined the term "electronic money" and, unless these four criteria specified in APS 2002 were met, the financial sums in question could not be considered electronic. Thus, according to the author, APS 2002 introduced a new term with respect to how money is viewed, i.e. the term "electronic money". As a result of APS 2002, money can be classified in terms of its form as follows:

- cash – banknotes and coins,
- cashless – accounts held at banks or other authorised financial institutions,
- electronic – a cash value entered within an electronic financial tool.

1.1 Change in 2009

In 2009, Act No. 284/2009 Coll. (hereinafter referred to as "APS 2009") on payment systems came into force, again with the aim of transposing several EU directives referred to in § 1 APS 2009 into Czech legislation, i.e. Directive of the European Parliament and the Council 2009/110/EC dated 16 September 2009 (hereinafter referred to as "Directive 2009") on the approach to the operation of electronic money institutions, on their performance and caution supervision over this operation, an amendment to Directives 2005/60/EC and 2006/48/EC and the cancellation of Directive 2000/46/EC. This norm introduced *inter alia* the term "electronic money institution" that, under specific conditions stipulated in the directive, was entitled to issue (but not emit) electronic money.[5] In addition, this directive also contained a new definition of electronic money which article 2 of para. 2 of Directive 2009 defines as follows:

"Electronic money maintains electronically as well as magnetically the cash value expressed by a claim on the issuer issued against the receipt of financial sums for the purpose of performing a payment transactions defined in article 4 point 5 of Directive 2007/64/EC and received by a natural person or corporate body other than the issuer of the electronic money".

The above features are similar to those specified in Directive 2000 with the exception that the requirement that electronic money should be maintained in an electronic medium or, according to the transposition of APS 2002, within an electronic payment tool was omitted and that it is sufficient for the cash value to be maintained electronically or magnetically. No specification was set out as to where the electronic money should be maintained. Moreover, Directive 2009 no longer specified where the cash value should be maintained,

4 *E.g. compare DVOŘÁK P. (2015) Bankovnictví pro bankéře a jejich klienty, SCHLOSSBERGER, O. and Ladislav HOZÁK. (2005) Elektronické platební prostředky, KLIMIKOVÁ, M. Platobný styk. (2008), NOVÁKOVÁ V. and V. SOBOTKA Slabikář finanční gramotnosti: učebnice základních 7 modulů finanční gramotnosti. (2011) or BARAK, J. and working group (2003) Zákon o bankách – komentář a předpisy související.*

5 *See provisions in article 2 para. 1 of Directive 2009.*

i.e. whether in a financial or payment tool or in the central server of a bank or other issuer. The remaining two criteria remained virtually unchanged. It is necessary to point out here that both Directive 2000 and Directive 2009 emphasized the fact that electronic money can only be issued if its value of the same amount (or not lower value) was received by this issuer. Again, it fails to mention whether this applies to the receipt of cash or of cashless money via a transfer from a client's account - the potential holder of electronic money issued by the issuer of electronic money.

The transposition of this part of the Directive into Czech APS 2009 resulted in the following definition:

"Electronic money is a cash value that:
a) represents a claim on those who issued it,
b) is maintained electronically,
c) is issued against the receipt of a financial sum for the purpose of performing a payment transaction and
d) is received by persons other than the issuer". [6]

Compared to the original text in APS 2002, a small change is evident in the second condition concerned with fulfilling electronic money requirements, i.e. that related to maintaining the cash value electronically and not within an electronic financial tool.

In the author's opinion, this small change in the characteristics of electronic money led to the question as to whether money can indeed be classified as cash, cashless and electronic. Is this question therefore justified? Before attempting to answer the question, the author intends to provide a definition of cashless money in the context of current legislation.

2 Cashless Money

As previously mentioned, general theoretical literature states that **cashless money may take the form of accounting entries in the bank accounts of clients held at banks or other authorised institutions.** Cashless money is transferred to such accounts via a cashless transfer or by means of the payment of cash at institutions which produce a written receipt of the cash payment to the client's account whereupon the cash is deposited in the safe room of the respective institution or is sent to the Czech National Bank (CNB) or another bank. Providers of payment services consist principally of banks and savings and credit associations since financial sums paid to the latter two institutions are usually considered to be deposits. Since 2009, however, in accordance with APS 2009 it has also been possible for financial sums to be placed with payment institutions and providers of small-scale payment services for the provision of payment services on the basis that a client's non-implemented financial sums may be deposited in an account registered at such institutions. Notwithstanding, such sums are not considered deposits.[7]

6 Quotation from § 4 of Act No. 284/2009 Coll., on payment systems.

7 See § 19 APS 2009.

In neither APS 2009 nor APS 2002 is cashless money specified. Indeed, the various legal regulations concerning cash are set out in Act no. 136/2011 Coll., on the circulation of banknotes and coins including related implementing regulations. Nevertheless, the act does not directly provide a description of the term "cash"; rather it principally addresses the characteristics of banknotes and coins and the handling thereof.

With respect to the issue of cashless money as entries to clients' accounts at a respective institution, such records are maintained in the respective bank's day book whether it is in paper or other form. For the past several decades such record-keeping has been conducted electronically, i.e. in the form of electronic entries at banks or other institutions. However, this has never been the case with respect to electronic money, with regard to which the recording either takes the form of a client deposit (often sight deposits) at a bank or savings or credit association or "hot" financial sums registered in a payment account at a payment institution or provider of small-scale payment services. In both cases, however, the financial sums involved will serve in the future as payment services. Moreover, such financial sums registered at banks or savings or credit associations may become a different deposit by virtue of Act No. 89/2012 Coll., the Civil Code, § 2676. A savings book or one-time deposit of a different type may be involved in accordance with the regulations of the bank or savings or credit association. Nevertheless, the role of financial sums entrusted to a payment institution or provider of small-scale payment services cannot be changed. Moreover, they cannot even be interest-bearing since, as previously emphasised, they do not represent deposits and they must not be used in connection with the other business activities of the payment institution unless APS 2009 sets out otherwise.[8]

3 Cashless Money versus Electronic Money

It is intended that this part of the essay will focus on a comparison of the characteristics of electronic money as defined in APS 2009 with those of cashless money as outlined previously.

In order to be considered electronic, money must fulfil certain fixed criteria as discussed in the introduction to this paper. The first criterion that must be met in order that money is to be considered electronic is that it applies to **a claim against the issuer of the electronic money.** However, if cashless money is deposited with a bank or savings or credit association (in this part of the paper the author intends to disregard the fact that cashless money can also be received by payment institutions or providers of small-scale payment services under conditions stipulated in APS 2009), it also represents a claim of the client on the respective bank or association. Conversely, the bank or association records such sums received in its accounting system as a liability vis-a-vis the client. Such financial sums should also be recorded by electronic money institutions, although this depends on how exactly the electronic financial sums are transferred to the holder. Nevertheless, this criterion can be regarded as identical both in terms of electronic and cashless money.

8 Compare § 20 par. 4 APS 2009.

The second criterion concerns the fact that **electronic money must be maintained electronically** which means that money is deposited directly either within an electronic financial tool (e.g. an electronic wallet) or is registered in a central computer system. The issue of whether electronic money is or is not recorded in an account is not mentioned in APS 2009 (nor in APS 2002). Nevertheless, it must be assumed that there has to be some level of record-keeping since a holder of electronic money is legally entitled to request a reverse exchange from the issuer at a ratio of one-to-one.[9] Thus the issuer must be aware of how much of the electronic money of the client has not been spent and, should the holder request a reverse exchange in the form of cash or cashless money, the issuer is legally bound to do so. Cashless money is currently also registered electronically in the central computer of banks or savings or credit associations; nevertheless, this is not a statutory obligation. APS 2009 refers to managing payment accounts (specifically, bank payment accounts are described as current accounts which, however, by virtue of Act 513/1991Sb., the Commercial Code[10], were always regarded as deposit accounts); however, it does not mention anything concerning the methods or technology to be used in their management. It can be assumed that it is possible to manage such accounts via book accounts as was common in the days before the advent of computer technology. This, however, is not an option with respect to electronic money since the process requires the electronic (by virtue of Directive 2009) management (recording) thereof or "insertion" into the respective medium. It can be concluded, therefore, that this criterion is essential with regard to electronic money, regardless of the fact that this principle does not refer to cashless money. However, in reality, cashless money is currently also recorded electronically at banks or other providers of payment services.

A further criterion consists of the fact that electronic money **is issued against the receipt of financial sums for the purpose of performing payment transactions.** This criterion is unique when comparing these two categories, i.e. this condition specifies that electronic money cannot be created if it has no further underlying interest. Electronic money can be issued only by an authorised agent that is obliged to ensure that the amount of electronic money will always be covered by a real value paid in cash or will be transferred to the credit of the issuer's account managed at a financial institution (often at a bank or a savings association) as cashless money. No such criterion applies to cashless money since it is not issued but simply transferred from one account to another, i.e. it was created either via the issuance of ready money that the client had previously physically delivered to the financial institution which was then transferred to the client's account in the form of a book entry or it was obtained as a result of the fiduciary issue of cashless money. However, one aspect is the same, i.e. both electronic money and ready money or cashless money serve as transaction payments. Electronic money is used for the payment of goods or services and the clearance thereof is conducted in a cashless manner; nevertheless, there may be a difference with respect to its transfer. If it is maintained within an electronic payment tool, electronic money is then transferred from its medium to the terminal of the goods or services provider who then forwards it for clearance by the relevant processing bank. Then it is entered into the client's account in the form of cashless money, most often to a current or payment account. However, if the electronic money takes the form of an

9 See § 124a. APS 2009

10 The Act was repealed on 1 January 2014.

electronic entry in the central computer of the issuer, the use of a payment tool initiates the transfer of the input for the clearing of the relevant amount of electronic money as a debit to the issuer's account and a credit to the account of the respective goods or services provider. The electronic money issuer then has to perform a mirror "accounting" transaction in the accounting books of the respective client and thereby reduce the electronic money value by this accounted sum.

The final criterion consists of the condition that the electronic money amount has to be accepted by persons other than those who issued it, i.e. that the acceptance of the electronic money issued is ensured by more than one subject than the issuer. This criterion is relatively common with respect to cashless money; however, it is also true that cashless money can take the form of money used in the transfer of financial sums between two accounts held by the same client and at the same financial institution. If electronic money was used only for the payment of goods and services provided solely by the issuer, this would not represent electronic money in terms of APS 2009, even though all the other criteria might be met. In such cases it might be considered as referring to subscribed services or to an advance payment for the goods or services of the respective subject. Moreover, APS 2009 does not require that the subject providing such services have a special licence for the conducting of such a business relationship; this commonly refers to prepaid loyalty cards issued by various retailers etc.

4 Virtual Money

Virtual money is not currently regulated.[11] Literature commonly refers to the categories of "digital money", "virtual money" and "cryptocurrency".[12] However, it is difficult to differentiate between expressions such as "virtual" and "digital" money. For example, Bitcoin is often referred to as virtual as well as digital cash.[13] Virtual currency might be considered to be private money used for the purchase and sale of goods within various online communities such as social networks, virtual worlds and online games. Digital money differs from virtual money used in the "real world", e.g. Bitcoin is suitable for both categories yet only one official methodological guideline, issued by the relevant Czech state authority, defines Bitcoin as digital currency. However, the Bitcoin virtual currency does not fulfil the definition of "electronic money" in terms of the APS.

The EU defines virtual money as the digital representation of a monetary value that is not issued by a central bank or public authority, but is used by natural or legal persons as a medium of exchange and may be transferred, stored or traded electronically. Although a number of these characteristics resemble the functions of money or properties that fall

11 As at 14 March, 2016

12 E.g. WAGNER, A. (2014) Digital vs. Virtual Currencies. Available at: https://bitcoinmagazine.com/15862/digital-vs-virtual-currencies/

13 WAGNER, A. (2014) Digital vs. Virtual Currencies. Available at: https://bitcoinmagazine.com/15862/digital-vs-virtual-currencies/

within the competence of EU E-Money (Ed. Author - see Directive 2009), it is safe to state that virtual money as the digital representation thereof is not electronic money.[14]

Cryptocurrency might be considered a form of digital currency with respect to which encryption techniques are used in order to control the generation of units of currency and the verification of the transfer of funds and which operates independently of central banks.[15] The emission of cryptocurrency is based on cryptographic methods such as proof-of-work and asymmetric encryption. The operation of such systems is decentralised in the form of a distributed computer network. With cryptocurrency no forced cancellation of transactions exists and funds cannot be frozen or confiscated without access to the private owner key. It is normal for an upper limit to be set for the total issue volume. Currently, cryptocurrency is pseudonymous – all related transactions are indeed public, but have no ties to particular persons. It can be stated that the terms "digital money", "virtual money" and "cryptocurrency" are almost synonymous for a category of money that does not have a real basis in the "real economy".

In conclusion the legal distinction between "cryptocurrency", "digital" and "virtual" currency in essence is unclear since no general legal regulation referring to this "currency" has yet been issued in the Czech Republic. Further, for the purposes of simplification, the term "digital money" will be employed herein. This begs the question as to whether "digital cash" and "cryptocurrency" can be considered to be electronic money within the meaning of the APS and relevant EU directives.

In order to clarify the role of virtual and digital money, the author proposes to provide a number of examples of opinions concerning the status of Bitcoin as the best known example of this commodity:

4.1 China

Bitcoin is not banned in China despite the fact that the regulation of Bitcoin is uncertain and financial institutions working with Bitcoin are advised to be particularly cautious concerning its use. The People's Bank of China has announced plans to strengthen the regulation of Bitcoin transactions, its distribution and other aspects related to this digital currency. It is intended that the new rules will clarify the government's position on trading in Bitcoin. In December 2013, the People's Bank of China decided to instruct financial institutions and payment service providers not to conduct Bitcoin transactions (Report No. 289),[16] and ruled that the payment systems of other countries should cease to conduct business with Chinese Bitcoin exchanges. In January 2014, however, the stance of the Chinese government was eased in this respect and the Chinese Bitcoin Exchange reopened in accordance with the opinion that report number 289 simply required registration with

14 *About Europena Banking Authority (2015) EBA Opinion on "virtual currencies". Available at: https://www.google.cz/?gws_rd=ssl#q=EBA+Opinion+on+%E2%80%98virtual+currencies%E2%80%99*

15 *http://www.oxforddictionaries.com/definition/english/cryptocurrency*

16 *CHEN, C. (2014) China and Bitcoin: Two Chinese Banks Announce That They Will Cancel Accounts Associated with Bitcoin or Litecoin. Available at: https://www.cryptocoinsnews.com/two-chinese-banks-announce-will-cancel-accounts-associated-bitcoin-litecoin/*

the Chinese Ministry of Industry and Information Technology and did not totally forbid transactions between Bitcoin and the yuan. Information subsequently issued on this subject in March 2014 was generally seen as positive in that it strengthened overall legal certainty in this respect which, in turn, will most likely lead to the expansion of business development using Bitcoin in China.

4.2 Finland

Finland's central bank initially refused to acknowledge Bitcoin as a currency, but then decided to include it in financial services.[17] The central bank opined that Bitcoin did not fall under the official definition of a currency as set out in legislation. Moreover, Bitcoin is not considered to be electronic money in Finland since the definition of electronic money requires that there is a publisher responsible for issuance, i.e. a condition which is not fulfilled in the case of Bitcoin.

4.3 France

The Autorité de Contrôle Prudentiel (ACPR) issued clear instructions relating to Bitcoin in January 2014 which warned French citizens of the danger of using Bitcoin.[18] This warning was similar to that published in an ECB directive and highlights the lack of control that Bitcoin users have, its extreme instability and the potential for its criminal exploitation. The guidelines also stated that any exchange office operating in France and exchanging this virtual currency must have concluded an agreement with the central bank or must work with a company registered for the depositing of financial resources.

4.4 Italy

The situation concerning Bitcoin in Italy is similar to that in the wider EU. Italy implemented an EU directive on the use of electronic money in 2009 via a number of government regulations commencing in 2012 defining electronic money and determining those persons authorised to issue electronic money. The use of electronic money is permitted but only by banks and electronic money systems which means that private sector agents must be approved and registered by the Central Bank of Italy. With the exception of these limitations, Italy does not regulate the use of Bitcoin which suggests that in Italy there is no official engagement in virtual money.

4.5 Japan

Currently, there is no legislation in Japan referring specifically to the use of Bitcoin; however, a number of government statements have been issued aimed at Bitcoin users and traders. In March 2014 the Prime Minister's Office issued an official statement highlighting that the Bitcoin currency does not fall under Japanese legislation and restricting com-

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17 STANLEY-SMITH, J. (2014) Finland recognises Bitcoin services as VAT exempt, 2014. Available at: http://www.internationaltaxreview.com/Article/3400689/Finland-recognises-Bitcoin-services-as-VAT-exempt.html

18 HAJDARBEGOVIC, N. (2014) French Regulator Requires Bitcoin Exchanges to Register. Available at: http://www.coindesk.com/french-regulator-requires-bitcoin-exchanges-register/

mercial banks from providing this product.[19] In the same statement it confirmed previous information that the Japanese Ministry of Finance and tax authorities were exploring the possibility of taxing Bitcoin and the potential for its regulation. At the same time the Japanese government announced that Japanese banks were obliged to report any suspicious potentially money laundering activities conducted by means of this digital currency.

4.6 Germany

Germany was the first country in the world to set out clear rules for companies working with Bitcoin. The German Central Bank warned investors that Bitcoin was both a risky and "highly speculative" currency. Furthermore, the German Finance Ministry issued a clear statement on how Bitcoin should be handled from the tax and administrative standpoints. In August 2013 German Finance Ministry officials issued several statements which established that Bitcoin cannot be regarded as a foreign currency asset, nor as electronic money and is considered to be "private money".[20] Further, according to the Ministry, Bitcoin is an "accounting unit" and not foreign exchange and, therefore, it is not governed by regulations relating to financial instruments.

4.7 Russia

In January 2014 the Central Bank of Russia issued a statement on the use of Bitcoin establishing that it is a substitute for money and that, therefore, its use is prohibited in Russia. The Central Bank of Russia also warned against the misuse of Bitcoin for the purpose of money laundering and the financing of terrorism and stated that any Bitcoin exchange for free convertible currency would be considered a suspicious transaction.[21] In September 2014, Deputy Finance Minister Alexei Moiseev stated that during 2015 legislation would be approved prohibiting the exchange of Bitcoin for fiat money.

5 Electronic Money versus Digital Money

The question must be posed as to whether "digital money" and "cryptocurrency" can be considered electronic money in accordance with the APS and the appropriate EU guidelines. Based on what has been stated above, it is perhaps reasonable to claim that the answer is a definitive no; indeed, they appear to form a completely different category of their own and can be differentiated in terms of several aspects as summarised in the following table:

19 *CRUZ, K. (2014) Bitcoin Regulation in Japan. Available at: https://bitcoinmagazine.com/17508/bitcoin-regulation-in-japan/*

20 *CLINCH, Matt. (2013) Bitcoin recognised by Germany as 'private money'. Available at: http://www.cnbc.com/id/100971898*

21 *Russian Central Bank warns against using Bitcoin (2014). Available at: http://rt.com/business/bitcoin-warning-russia-bank-280/*

Table 1: The differences between digital and electronic money

Criterion	Digital money	Electronic money
Accessibility	Largely limited to Internet connection	Access to electronic devices such as mobile phones, and an agent network
Value	Determined by supply and demand, and trust in the system	Equal to amount of fiat currency exchanged into electronic form
Customer ID	Anonymous	Financial Action Task Force standards apply for customer identification (though such standards permit simplified measures for lower risk financial products)
Production	Mathematically generated ("mined") by peer network	Digitally issued against receipt of equal value of fiat currency of central authority
Issuer	Community of developers, called "miners"	Legally established e-money issuer
Regulator or oversight	None, though regulators are currently exploring	Regulated by central authority, typically central bank

Source: author's modifications[22]

The first criterion refers to the **accessibility** of given forms of money. Digital money is only available via an internet connection, whereas electronic money can be deposited electronically, for example via a mobile telephone, by payment card (in the form of an electronic wallet) or within the network of a given issuer.

The **value** of digital money is highly disputable since it is dependent not only on the level of trust in a given currency, but also on its supply and demand.[23] Electronic money can be issued merely as a counter-value to deposited cash or as money sent to an issuer of electronic money in a cashless manner.

A further important criterion concerning the differentiation of digital money and electronic money consists of the degree of **relative anonymity**. Rules relating to the correct **identification of the client** are fully adhered to with respect to the issuance of electronic

22 *PARKER, S. R. (2014) Bitcoin vs Electronic Money. CGAP.org. Available at: http://www.cgap.org/publications/bitcoin-vs-electronic-money*

23 *See for example FILLNER, K. Bitcoins – 7 reasons why they deserve your attention this year (Bitcoin - 7 důvodů, proč si letos zaslouží vaši pozornost). In.: Bankovnictví No. 9/2015.*

money in accordance with valid legal regulations and the recommendations of the multinational FATF[24] organisation.

Moreover, the criterion related to the so-called "**production**" (acquisition) of money also differs in that:

- Electronic money is not issued, i.e. in the sense of emitted, rather it is issued versus the acceptance of non-cash money or in the form of cash. Thus, electronic money represents the holder's claim on the issuer and issuance cannot affect the monetary mass.

- Virtual money (digital) is "mined", i.e. Bitcoin production is technically known as "mining".[25] This is a special process the complexity of which is algorithmically programmed and increases continuously in line with the amount of technical resources involved. Mining is the process of using computer resources to process transactions for the implementation of a safety net and for maintaining synchronisation between all the users within a given system.

This criterion is closely linked to the issuer or emitter criterion. The issuer of electronic money is a licenced or registered subject established in accordance with valid legislation, i.e. according to the APS for example in the Czech Republic, while emitters of digital money are unregulated subjects. Moreover, the final criterion, **regulation and supervision** by a central authority is based on the same principle, i.e. as stated above, digital money, in the main, has yet to be regulated, while electronic money is already subject to regulation.[26]

6 Economic Aspects

Despite the fact that this paper is mainly concerned with electronic money, the deductive method will also be used in order to consider whether electronic money, as well as cashless and digital money, influences two important issues:

a) the monetary base and
b) the money supply.

In order that the facts resulting from the afore-mentioned analysis of individual monetary terms be applied to these two areas, the author first intends to provide selected background information.

These two categories are essentially related since the monetary base (B) can be considered to be money in circulation held by the public (i.e. banknotes and coins) and balances in trading bank accounts held at the central bank. Currency is held by households, compa-

24 The Financial Action Task Force.

25 ANTONOPOULOS, A. (2014) Mastering Bitcoin. O'Reilly Publishing, p. 17.

26 See for example. FILLNER, K. Bitcoins – 7 reasons why they deserve your attention this year (Bitcoin - 7 důvodů, proč si letos zaslouží vaši pozornost). In.: Bankovnictví No. 9/2015.

nies and the public sector, including cash held at trading banks,[27] i.e. in the form of cash as banknotes and coins. It can be expressed by the equation:

$$B = C + R, \tag{1}$$

where C is currency held by the public,
R is balances in trading bank accounts held at the central bank (bank liquidity at the central bank, reserves).

The money supply (M) is then understood (in accordance with the sources stated under footnote no. 27) to be the sum of the currency and deposits held by the public at trading banks. This equation can be expressed as:

$$M = C + D, \tag{2}$$

where C is currency held by the public,
D is deposits held by the public at trading banks.

The issuance of banknotes and coins into circulation is termed "emission" and money issued in this way is called **currency** and forms, therefore, part of both the monetary base and the money supply. If banknotes and coins have not been released into circulation, they are not considered money (they are not bearers of the functions of money) but are merely a reserve (a product) stored at the central bank (this essentially involves storage in a warehouse).

The author now proposes to provide two case simulations in order to ascertain to what extent the issuance of electronic money affects the monetary base and money supply.

Case 1

The currency held by the public C amounts to 100 units, public deposits in trading banks D to 200 units and balances in trading bank accounts held at the central bank R 500 units. If electronic money (P_{el}) is issued as a counter-value of 20 units of currency, i.e. cash money is converted into electronic money, the equation according to (1) is as follows:

$$B = (C - P_{el}) + R \tag{3}$$

This results in a currency reduction of twenty units due to the fact that only banknotes and coins are considered to constitute currency. The monetary base is then reduced by 20 units, i.e. from 600 to 580.

In the same way, the money supply M will also be reduced according to equation (2), i.e. to 280:

$$M = (C - P_{el}) + D \tag{4}$$

27 *E. g. JÍLEK, J. (2013) Finance v globální ekonomice I – Peníze a platební styk. Praha: GRADA, p. 185, POLOUČEK, S. a kol. (2013) Bankovnictví. Praha: C.H.Beck, p. 51 or MEJSTŘÍK, M., PEČENÁ, M. a P. TEPLÝ (2014) Bankovnictví v teorii a praxi/ Banking in Theory and Practice. Praha: Karolinum, p. 142-144.*

The issuance of electronic money appears therefore to reduce both variables, i.e. the monetary base B and the money supply M in the amount of the counter-value of the currency due to a reduction in the set of money in circulation C.

However, issuers of electronic money are obliged according to the APS[28] to protect the funds of holders of electronic money which has been submitted to their issuers for a change of form and to do so in two ways, one of which involves the depositing of the submitted currency in trading bank accounts or savings or credit associations. These funds then appear in the trading banks' accounts at the central bank in a certain amount, but up to a maximum of 100% of the electronic money issued P_{el}.

It is therefore possible to form the partial conclusion, based on the afore-mentioned considerations, that electronic money issued against a currency need not influence the monetary base B variable – there could be both an equalling of the value of the issued electronic money Pel on the one hand and an increase in the value of trading banks' balances at the central bank D in an amount from 1% to 100% of the value of the issued electronic money on the other. This can be expressed by the following equation:

$$B = (C - P_{el}) + (R + P_{el\,[0-100\%]}) \tag{5}$$

In terms of the example provided, the currency base B indicator will be in a value range of from 580 to 600 units.

However, this conclusion cannot be applied to the money supply since a reduction in the value of currency C as a counter-value of the electronic money issued is not balanced by an increase in public trading bank deposits D since, in turn, the electronic money issued does not constitute a deposit and thus does not influence the amount of this indicator.

Case 2

In this case electronic money is issued as a counter-value for cashless money received. Given that the holders of electronic money are either households, companies or the public sector, the issuance of electronic money P_{el} in the amount of 20 units will not reduce (1) the currency C, but may increase the indicator R due to the protection of the funds of electronic money holders which were transferred to the issuer's account as in Case 1. The counter-value thus acquired of the issued electronic money may appear as an increase in the balances of trading bank accounts at the central bank R. The cashless transfer of funds when issuing electronic money P_{el} may therefore have an influence on the monetary base in that it may be caused to increase by up to 20 units within the context of variable R. The currency base may therefore move in the interval from 600 to 620 units. This can be expressed as follows:

$$B = C + (R + P_{el\,[0-100\%]}) \tag{6}$$

28 § 52e point b) APS.

As far as the money supply M indicator and the issuance of electronic money as the counter-value of a cashless transfer in the amount of 20 units is concerned, the money supply is reduced by this amount in equation (2) since public deposits at trading banks D are reduced by this amount (the value of deposits to be used for the issuance of electronic money is reduced since they will be sent in the form of cashless money from the client's bank, i.e. the holder of the electronic money in relation to its issuer). The money supply will thus have a value of 280 units.

This consideration can be expressed as follows:

$$M = C + (D - P_{el}) \tag{7}$$

Given that the issuance of electronic money may influence both indicators, it is regulated by the central authority in such a way that the conversion of one form of money into another is under direct control and is unable to lead to the uncontrolled issuance of such money or even to its emission, which would not be covered by the currency or by trading bank deposits.

With respect to the category of "digital or **virtual money**", such funds are the consequence of "mining" which, admittedly, is similar to the emission of money. However, **it is not possible to consider them as constituting currency** if they do not fall under the regulation of the central emitting bank as substantiated above. Mined digital money may act as a means of trade – it can be purchased (acquired) thus the purchase thereof will have an influence on both currency C (the currency will be reduced by the purchase for "cash") and on deposits D (public deposits are reduced solely due to the cashless purchase of digital currency; they cannot increase the value of these deposits by the same amount due to the fact that banks do not hold accounts for virtual currencies). Digital money, therefore, cannot logically influence the bank balances at the central bank R indicator since, presently at least, central banks essentially do not recognise virtual money.

The fact that digital money has escaped regulation by central authorities (emitting banks) means that its value does not feature in the directly monitored indicators of the monetary base B or the money supply M, notwithstanding the fact that it may influence the amount thereof during the trading process.

Conclusions

The paper focused on:

- the analysis of the characteristics of the term "electronic money" as defined by Directive 2000 and its recoded version Directive 2009 with a comparison of their transposition into APS 2002 and APS 2009,
- the characteristics of "cashless money" and "digital money" and the definition thereof,
- a comparison of the category "electronic money" in accordance with APS 2009 with the term "cashless money" that is not defined in Czech legislation (nor in that of the EU),
- a comparison of "electronic money" and "digital money",
- the question of whether electronic money and virtual (digital) money influence the monetary base and the money supply indicators.

From the above analysis the author concludes that it is impossible to consider digital currencies such as Bitcoin and Litecoin simply as another form of electronic money in terms of EU legislation, namely the 2009 Directive. This view is further justified by the above summary of the approaches of various countries to the issue of virtual money. The Czech Republic has not yet regulated virtual currencies with the exception of the publication by the Czech Ministry of Finance in September 2013 of "Methodical instruction no. 2 of the Financial Analytical Unit of the Ministry of Finance". The instruction states that trading with any digital currency should be considered risky and calls on financial institutions and other entities to consider any trade transaction amounting to over EUR 15,000 as suspicious and to notify the FAU thereof.

The analysis led to the following conclusions:

The terms of Directive 2000 differed from those transposed into APS 2002 in terms of a difference in the second criterion of what can be regarded as electronic money. In accordance with the transposition norm (APS 2002), only the value contained (maintained) within an electronic financial tool can be considered electronic money.

The terms transposed into APS 2009 basically corresponded to those of Directive 2009 as well to the requirements of the original Directive 2000 which was subsequently repealed.

The terms "electronic money" and "cashless money" are two different legal terms and are significant in terms of theoretical interpretation. The term "electronic money" is subject to legal regulation whereas "cashless money" is not directly regulated. Existing legal regulations, however, recognise this term.

The category "cash" or "ready money" is clearly defined in the relevant legal regulation.

Virtual money cannot currently be considered to be electronic money since it does not meet requirements set out in European or Czech legislation.

The issuance of electronic money influences both the monetary base indicator and the money supply since the issuance thereof takes place in the form of a transformation of money from cash or cashless money into electronic money. This may influence variables such as currency C, public trading bank deposits D and trading bank account balances at central banks R.

By virtue of its being "mined", virtual (digital) money is in fact newly created which is closely linked to the term "the emission of money". However, its mining does not involve the transformation of one form of money into another, rather, "new funds" are created, i.e. so that it enters individual sectors of the economy as something "extra". Further, it is used for trading purposes, i.e. it can be purchased in the financial markets for currency or cashless money. This, as outlined above, may influence both the monetary base and the money supply. Given that the "creation" of digital money in most cases remains unregulated by central banks, which do not recognise the "emission" thereof, such money is not directly included in the currency variable.

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Prediction of Emission Allowances Spot Prices Volatility with the Use of GARCH Models

Predikce volatility cen emisních povolenek s využitím modelů GARCH

DANIELA SPIESOVÁ

Abstract

For several years, the system of emission allowances trading has been dealing with a crisis mainly due to the falling prices of emission allowances. That said, the partial aim of this paper is to create an overview of EUA trading options and acquaint readers with the development of the emission allowances price. Another partial aim is to predict the volatility of prices of emission allowances with the use of BAU scenario, i.e. without any intervention. ARIMA models are used to model the conditional mean value and linear ARCH or GARCH models are used to model conditional variance. The uniqueness of this paper lies in the fact that there are many expert studies dealing with the prediction of the price of allowance but there are only a limited number of scientific studies concerning the prediction of volatility which is the crucial element for trading with emission allowances on the exchange. Based on these two results the main aim of this article is to show possible malfunction of EU ETS in future based on the price development of EUA in time and on volatility prediction. The results of this study confirm that to predict the conditional variance and then volatility, it is adequate to use the cluster model AR(1,8,12)-GARCH(1, 1) without constant, where in the long-term, the square root of the conditional variance inclines towards stable value. Based on the analysis of EUA prices it is obvious that the system is not efficient and does not fulfill its purpose. These two partial conclusions suggest that in case of non-intervention of the European Commission the whole mechanism may fail.

Keywords

emission allowance; volatility; ARIMA; GARCH; prediction, spot price

Abstrakt

Již několik let se systém obchodování s emisními povolenkami potýká s krizí především kvůli klesajícím cenám emisních povolenek. Dílčím cílem tohoto příspěvku je stručně popsat možnosti obchodování s emisními povolenkami EUA a seznámit čtenáře s problematikou vývoje jejich cen. Druhá část textuje věnována predikci volatility cen emisních povolenek za předpokladu BAU scénáře, tj. bez jakýchkoliv vnějších zásahů. K modelování podmíněné střední hodnoty je využito modelů typu ARIMA, k modelování podmíněného rozptylu pak lineárních modelů ARCH potažmo GARCH. Unikátnost článku spočívá ve skutečnosti, že existuje mnoho odborných studií zabývající se predikcí ceny povolenky, ale vědeckých prací na predikci volatility, která je pro obchodování s emisními povolenkami na burze zásadní, je pouze omezený počet. Hlavním cílem je na základě zkoumání vývoje cen EUA v čase a predikce volatility poukázat na možnou nefunkčnost EU ETS v budoucnu. Výsledky modelování potvrzují, že pro predikci podmíněného rozptylu a následně

i volatility je vhodný sdružený model AR(1,8,12)-GARCH(1,1) bez konstanty, přičemž v dlouhodobém horizontu inklinuje odmocnina podmíněného rozptylu ke stabilní hodnotě. Z analýzy vývoje cen EUA je zřejmé, že systém není efektivní a nesplňuje svůj účel. Z těchto dvou dílčích závěrů vyplývá, že v případě neintervenování Evropské komise může dojít k selhání celého mechanismu.

Klíčová slova
emisní povolenka, volatilita, ARIMA, GARCH, predikce, spotová cena

JEL Codes
C32, C53, Q56, Q58

Introduction

The Emissions Trading system (ETS) was launched by European Union in 2005 to create a tool that motivates the operators of installations emitting greenhouse gases to using more efficient technologies and reduce the amount of emissions. The aim of the EU ETS is to ensure that emissions reduce at the lowest cost by creating and trading emission allowances (EUA - European Emission Allowances). Böhringer and Lange (BÖHRINGER, 2005) indicate that the objectives of economic efficiency and free allocation of emission allowances are incompatible with the harmonized allocation rules to prevent distortions of competition. At the same time also shows that Member States have not implemented the optimal allocation in the first trading period 2005-2007. Therefore, the use of flexible mechanisms of the Kyoto Protocol, an international emissions trading, the Clean Development Mechanism (CDM) and Joint Implementation (JI), becomes an important issue.

In recent years, a number of empirical studies that deal with examining the price of emission allowances mainly from an econometric perspective grows. Among the authors of these studies are e.g. Daskalakis et al. (DASKALAKIS, 2005), and Paolella Taschini (PAOLELLA, 2006); Seifert et al. (SEIFERT, 2008), Uhrig-Homburg and Wagner (UHRIG-HOMBURG, 2006) and others. While Uhrig-Homburg and Wagner (2006) focus mainly on derivatives of emission allowances, Seifert et al. (2008) developed a stochastic equilibrium model to reflect the most important parameters of the EU ETS and analyzed the resulting dynamics of the spot price of CO_2.

There is a number of studies to predict the price of emission allowances for the third period. Daily and Bond-Smith (BOND-SMITH, 2010) summarized most of the existing models for predicting the price of allowances into two categories. The first category, "bottom-up" models, which typically do not provide feedback between developments in individual markets and the rest of the economy and cannot even simulate links between individual markets. Assumption of these models is that the market price of emission allowances equals to the unit cost of emissions reductions in a competitive market.

The second set of models is called a "bottom down", which are models describing the system from the top to the bottom. They are relatively complex, mostly dealing with economy as a whole and are usually based on aggregate sector data. In recent years there have been approaches that try these two methodological approaches to integrate into a single framework of general equilibrium. Böhringer and Rutherford (BÖHRINGER, 2009)

first directly integrate "bottom-up" and "top-down" description of the economic system in the so-called hybrid integrated model.

Models of volatility were first described by American economist F. Robert Engle (ENGLE, 1982) in 1982. He devised a model that should characterize the conditional heteroscedasticity of the stochastic process, for which he was awarded the Nobel Prize in economics in 2003. Models of volatility are, unlike other models of time series, dealing with modeling of random component based on the conditional variance. Among the basic linear models are ARCH and GARCH (FEDDERKE, 2003), (POPELKA, 2007). These are further described in the following text.

Benz and Truck (TRUCK, 2009) investigated the prediction of the price of allowance with the use of ARCH or GARCH models by analyzing the prediction from sample data and by comparing the results with alternative approaches. In this model, the conditional variance of time series is represented by the weighted sum of squares from previous observations. At the same time, they use Markov-switching model for the analysis of spot prices of carbon dioxide emissions to capture the heteroscedasticity of the time series. Their findings confirm that AR—GARCH models are effective when modeling the short-time conduct. Another analysis of price and the data of returns from emission allowances were carried out with the use of GARCH model in the study of Taschini and Paolella (PAOLELLA, 7/2007). These authors analyzed spot prices of one ton of SO_2 from 4. 1. 1999 to 16. 5. 2006. The source of the spot price of one ton of SO_2 was the Chicago Climate Exchange. Taschini and Paolella used only with 454 values for CO_2 when working on the study. It is necessary to note that both of these studies were primarily focused on the prediction of prices and not on the volatility issues.

The partial aim of this paper is to create an overview of EUA trading options and the development of the emission allowances price. This will be followed by predicting the volatility of prices of emission allowances with the use of BAU scenario, i.e. without any intervention. Based on that, the main aim of this article is to show possible malfunction of EU ETS in future based on the price development of EUA in time and on volatility prediction

1 EU ETS Trading and its Effectiveness

Emission allowance is an "asset corresponding to the right of the operator to emit one ton of CO_2" (Act no. 383/2012 Coll., § 2, letter t). This emission allowance enables polluters to sell them to each other. All companies (industry and energy) have been receiving emission allowances for free based on historical emissions; in the second trading period 2008-2012 it is a total of 86.8 mil. allowances annually for the Czech Republic. In the third period, ie. since 2013, there is a revision of the system, part of the allowances is allocated to facilities for free (based on benchmarking or on historical emissions) and the remainder is available to buy via auction.

In the years 2013-2020 the Czech Republic will have a total of 645 mil. of allowances; 342 mil. of allowances (54%) will be auctioned and 303 mil. of allowances (46%) will be

allocated to the Czech industry for free. By 2020 electricity producers will have received a total of 107.8 mil. of allowances for free, the rest they will have to buy (EUROPEAN COMMISSION, 2012).

Emissions trading can be done in several ways: currently daily futures are the most traded on London's financial and commodity exchange Intercontinental Exchange (ICE), but the emission allowances can also be purchased through forward contracts or direct sales.

ICE is the largest global network of exchanges and clearing houses for financial and commodity markets. ICE owns and manages 23 regulated exchanges. ICE Futures is the main market for emission allowances. ICE Futures products meet the requirements of the European Union Emissions Trading System. In April 2010, ICE acquired the European Climate Exhange (ECX). The first emission allowances were offered by the European Climate Exchange, founded in 2005, which stated emission products trading platform ICE Futures Europe.

The EU ETS was launched in early 2005 in order to control CO2 emissions-intensive sectors (e.g. Electricity generation and heavy industry). System is, however, struggling with inefficiencies due to low prices per ton of discharged greenhouse gases. After its beginning in 2005, the price of an allowance was € 30, which was according to the European Commission (EC) an expected price. The price, however, dropped as soon as possible due to the fact that the states requested an excessive amount of allowances during the preparations. This should have been changed during the second phase of trading (2008-2012). The EC demanded by some states to redo their National Action Plans (NAPs) in which they requested an excessive amount of allowances. Thanks to the price rose above € 20 per allowance. However, the economic crisis of 2008 caused an increase in the amount of allowances and their price dropped again. Currently, the value of allowances is - despite other measures taken by EC- far below the price that would encourage the European Commission to modernize installations emitting greenhouse gases again.

The price of emission allowances is currently around 5 euros per ton. This is much less than originally expected. Predictions in 2015 anticipated the end of last year to levels around 8.50 to 9 euros. Although two partial reforms, which should stabilize the market, were approved the price of allowances remains under pressure and react very strongly to prices of energy commodities. The break of the long-term trend of increasing prices of allowances took place on 11th December last year. After a slow recovery the price was finally closed in 2015 at 8.29 euros. However, in early 2016 a sharp downward trend continued. Since the beginning of this year, the allowance price fell by more than 40%.

There is a number of causes for the sharp price decline including speculators, international politics, or economics. Allowance is also part of the energy complex and as such it is related to the price of oil or electricity, and can be influenced even by such a thing as above-average temperatures as heating plant will not need so many emission allowances to fulfill their legal obligations.

2 Methodology

In this paper, we analyzed the time series of emission allowance spot prices for the period from 1. 1. 2008 to 31. 12. 2013. This period was chosen on purpose as it covers the whole second phase of ETS trading. The data contain values of allowances prices on the stock exchange for trading days, i.e. in the majority of the data set these are mostly prices from Monday to Friday. In total, there are 1521 observations in the data set. The most frequent value (modus) is 12.336 EUR/EUA. The minimal value of the price for the period of observation is 2.7 EUR/EUA and the maximum value is 28.3 EUR/EUA.

Given that financial data are very often characterized by high volatility, it is necessary to test the model for ARCH effect, i.e. presence of conditional heteroscedasticity. Regarding heteroscedasticity, it is a situation where the condition of finite and constant variance of random components is violated. The following model illustrates the conditional heteroscedasticity:

$$(lnX_t - lnX_{t-1})^2 = \alpha + \rho\,(lnX_{t-1} - lnX_{t-2})^2 + u_t \quad (1)$$

where X_t, X_t- represent values in the time series when time t is changed by one unit. The parameter α is calculated by the method of the smallest squares and u_t is a random component. If the parameter ρ (regressive parameter) is equal to zero, we cannot talk about heteroscedasticity.

When constructing the model of ARCH type, we face a major problem of choosing the model order. The common procedure for determining the order of ARCH type models is that at first a model of low order is estimated and then is this model modified for instance according to the results of statistic significance of the parameters or according to the analysis of standardized residuals. In the great majority of cases, low order models are sufficient, for instance: ARCH(1), ARCH(2) or GARCH(1,1), GARCH(2,1) etc.

For some time series, the high order is necessary to model volatility with the use of ARCH model which is generalized by adding the influence from previous volatility values. The resulting model is called GARCH model (GARCH - generalized autoregressive conditional heteroscedastic). GARCH models the movements of the conditional variance of residues and thus the following prediction of volatility is at the same time the prediction of the variance.

By extending the ARCH(1) model by conditional variance in the first delay, the GARCH (1,1) model of the conditional variance is in the form of:

$$h_t = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \quad (2)$$

The conditions $\omega > 0$, $\alpha_1 > 0$ a $\beta_1 \geq 0$ ensure the positive conditional variance. Model (8) is labeled as GARCH(1,1) and it can be used where it would be appropriate to choose ARCH model with many delays.

To describe the idea of GARCH models more closely, we rewrite the equation (2) as follows:

$$h_t = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} = \omega + (\alpha + \beta) h_{t-1} + \alpha(\varepsilon_{t-1}^2 - h_{t-1}) \quad (3)$$

The conditional variance in this form is then equal to the weighted sum of the variance h_{t-1} predicted in the previous period and the unexpected previous shock $\varepsilon_{t-1}^2 - h_{t-1}$. The parameter α measures the impact of this shock on the prediction for the next period, $(\alpha+\beta)$ represents the rate at which the shock effect will vanish in the following period. The closer is $(\alpha+\beta)$ to one, the longer time it takes to remove the shock.

If we add ε_t^2 to the both sides of the model (2) and subtract h_t, this model may be rewritten to the form of ARMA(1,1) model:

$$\varepsilon_t^2 = \omega + (\alpha_1 + \beta_1)\varepsilon_{t-1}^2 + \nu_t - \beta_1 \nu_{t-1}, \quad (4)$$

where $\nu t = \varepsilon_{t-1}^2 - h_t$. If $\alpha_1 + \beta_1 < 1$, then it follows from the equation that GARCH(1,1) model is stationary in covariations. The unconditional variance of the process $\{\varepsilon_t\}$ is in the form of:

$$\mathrm{var}(\varepsilon_t) = \omega / (1 - \alpha_1 - \beta_1) \quad (5)$$

It is therefore constant in time and the process $\{\varepsilon_t\}$ is unconditionally homoscedastic.

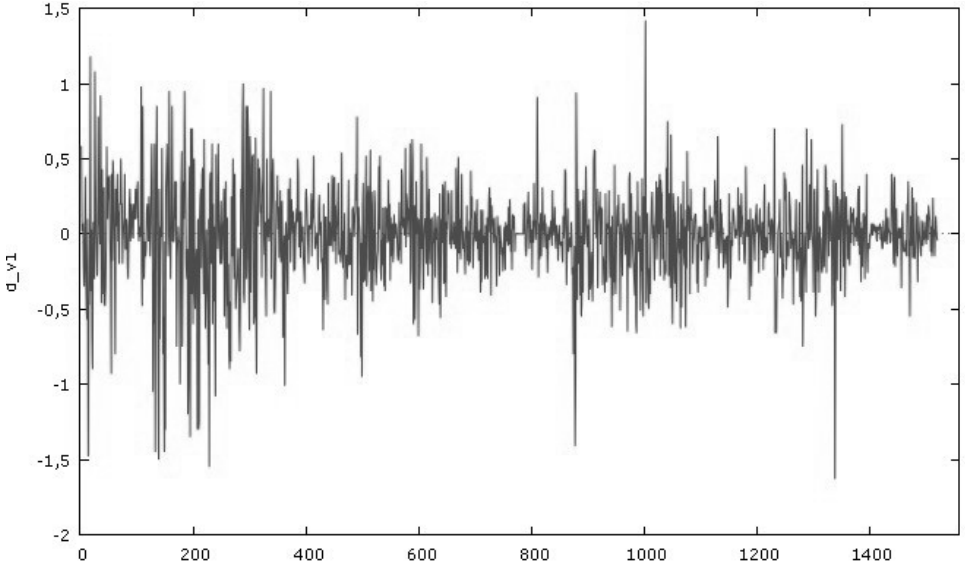
The number of model parameters for GARCH(1,2), GARCH(2,1), GARCH(2,2) can be gradually increased. This procedure is recommended by Tsay (TSAY, 2002). Overall, all GARCH models and their specifications are very efficient in the modeling of volatility.

The final phase of the construction of the volatility model is the verification of the adequacy of the chosen model based on standardized residues. These are obtained by subtracting the diameter from estimated residues and then divide this difference by the standard deviance. Other method of proving the model validity for the specific time series is testing of the non-systematic component – these are specifically tests of autocorrelation and conditional heteroscedasticity (for instance Ljung-Box Q-test, ARCH-LM test or GARCH-LM test.)

3 Prediction of Volatility

The time series of EUA prices was tested for the presence of the unit root with the help of the Dickey Fuller test, which was performed for the scenarios with a constant, without a constant and with a constant and a trend. The model with a constant appears to be the most adequate. Its conclusion is that for the given number of observations and the reliability value, we cannot reject the null hypothesis of the unit root existence, i.e. it is not the stationary time series, in other words, we may assume that the equation is in the first differences (Figure 1). This prerequisite was verified with the help of the autocorrelation and partial-autocorrelation function (ACF and PACF).

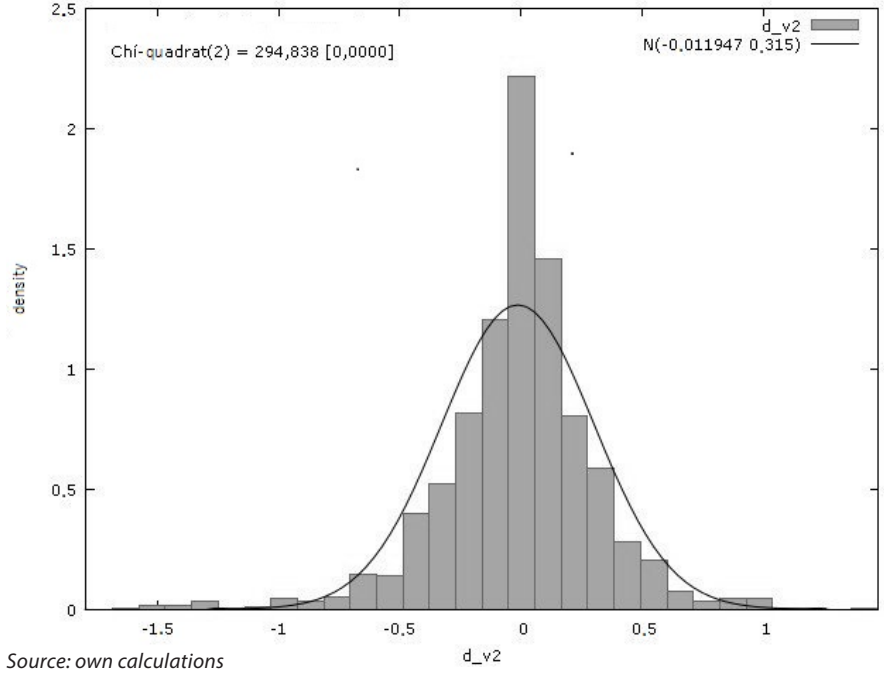
Figure 1: Differentiated time series of EUA (EUR/EUA) prices



Source: own calculations

The prerequisite of the normal distribution of residues is also important for the model. We test this prerequisite in our model. After we differentiated the data, we investigated their empirical distribution (see Figure 2 of the frequency distribution of residues).

Figure 2: Graph of the frequency distribution of residues



Source: own calculations

The data show the leptokurticity. This signifies that there are relatively many observations around the diameter and relatively many observations further from the diameter. The center of the histogram has a high peak and the tails are relatively larger in comparison with the normal distribution, i.e. there is a high probability value on the mean value and not insignificant probability of the remote observations (the distribution with the narrow waist and heavy ends). From above mentioned information follows that the distribution of residues is not in a normal nature, however, due to the sufficient number of observations, it can be assumed, based on the central limit theorem, that the normality prerequisite is fulfilled.

To predict the volatility, it is at first necessary to model the conditional mean value with the use of models AR, ARMA, or ARIMA. Predictions of, for instance financial assets prices, are very often made based on the models of the conditional mean value. In our case, we indentified the ARIMA [(1,8,12),1,1] model without a constant, which met the requirement for the minimum AIC, significant p-value and was then tested by ACF and PACF. The results of the model are shown in Table 1.

Table 1: The output of ARIMA [(1,8,12),1,1] model without a constant

ARIMA [(1,8,12),1,1] model without a constant	**coefficient**	**direct. error**	**z**	**p-value**
phi_1	-0.282922	0.136861	-2.067	0.0387 **
phi_8	0.0788961	0.0244957	3.221	0.0013 ***
phi_12	-0.0881966	0.0251873	-3.502	0.0005 ***
theta_1	0.391545	0.132915	2.946	0.0032 ***
Akaik's criterion	773.1933			

Source: own calculations (SW Gretl)

The detection of heteroscedasticity follows after the initial modeling. **Table 2** confirms the presence of ARCH effect as the p-value is almost zero. We therefore reject the null hypothesis and the heteroscedasticity is thus present in the model. Based on this result we can model the volatility of the time series.

Table 2: Test for ARCH of the 1. order

ARCH of the 1. order	**coefficient**	**direct. error**	**z**	**p-value**
$\alpha 0$	0.0832518	0.00640715	12.99	1.11e-036 ***
$\alpha 1$	0.137696	0.0254225	5.416	7.07e-08 ***
Null hypothesis: There is no ARCH effect Test statistics: LM = 28.8177 **P-value = P($\chi 2(1) > 28.8177$) = 7.95222e-008**				

Source: own calculations

The choice of the ARCH and GARCH model order follows next (Table 3 + Table 4).

Table 3: ARCH models

ARCH(q)	**coefficient**		**z**	**p-value**	**log-likelihood**	AIC
ARCH(1)	α_0	0.0768978	20.87	1.08e-096 ***	-363.0074	732.0149
	α_1	0.251373	5.58	2.31 e-08 ***		
ARCH(2)	α_0	0.0529628	15.39	1.97 e-053 ***	-307.1594	622.3189
	α_1	0.2739	5.82	5.75 e-09 ***		
	α_2	0.266806	6.3	2.97e-010 ***		
ARCH(3)	α_0	0.0459722	14	1.51e-044 ***	-284.7905	579.5811
	α_1	0.168519	4.04	5.33 e-05 ***		
	α_2	0.209461	5.301	1.15 e-07 ***		
	α_3	0.214541	4.56	4.90 e-06 ***		
ARCH(4)	α_0	0.0377719	12.88	6.02e-038 ***	-253.4524	518.9049
	α_1	0.125875	3.535	0.0004 ***		
	α_2	0.173518	4.817	1.46e-06 ***		
	α_3	0.165081	4.103	4.08 e-05 ***		
	α_4	0.202664	5.259	1.45 e-07 ***		

Source: own calculations

According to Gretl calculations, the best model is ARCH (4) with the lowest Akaike's criterion (AIC) and the highest Log-likelihood. Looking at p-values we can see that all of these are significant on the 5% significance level.

Despite this, AIC is too high; therefore we proceed to the next phase where we estimate the conditional variance with the use of GARCH model. We have tested all the possible combinations of GARCH(p,q) if p = 1,2 a q = 1,2, with or without constant. We can conclude that GARCH(1,1) is the best choice, see Table 4. GARCH(1,2), GARCH(2,1) and GARCH(2,2) have higher AIC values and some of their parameters are not significant at all. GARCH with a constant was constructed only for orders p=1, q=1 a p=1, q=2. Due to the fact that in every case the constant was insignificant and the information criteria higher than when modeling without constant, other variations of GARCH order with a constant were not further investigated.

Table 4: GARCH models

GARCH(p,q)	coefficient		z	p-value	log-likelihood	AIC
GARCH(1,1)	α_0	0.001385	3.414	0.0006 ***	-188.4058	384.8117
	α_1	0.115714	6.543	6.01e-011 ***		
	β_1	0.876846	53.63	0.0000 ***		
GARCH(1,2)	α_0	0.001549	3.172	0.0015 ***	-188.0793	386.1586
	α_1	0.095076	3.26	0.0011 ***		
	α_2	0.028903	0.8291	0.4071		
	β_1	0.867491	41.92	0.0000 ***		
GARCH(2,1)	α_0	0.001382	3.133	0.0017 ***	-188.4063	386.8126
	α_1	0.116201	4.404	1.06e-05 ***		
	β_1	0.876533	3.773	0.0002 ***		
	β_2	4.26E-11	2.01E-10	1		
GARCH(2,2)	α_0	0.002797	3.483	0.0005 ***	-186.6285	385.257
	α_1	0.096813	4.654	3.26e-06 ***		
	α_2	0.135699	5.496	3.88e-08 ***		
	β_1	1.13E-12	1.20E-11	1		
	β_2	0.75411	8.307	9.83e-017 ***		
GARCH(1,1) with constant	const.	0.001694	0.2866	0.7744	-188.3648	386.7296
	α_0	0.001385	3.413	0.0006 ***		
	α_1	0.115922	6.549	5.80e-011 ***		
	β_1	0.87668	53.62	0.0000 ***		
GARCH(1,2) with constant	const.	0.002234	0.377	0.7062	-188.0101	388.0202
	α_0	0.001556	3.18	0.0015 ***		
	α_1	0.094413	3.248	0.0012 ***		
	α_2	0.030236	0.8662	0.3864		
	β_1	0.866852	41.79	0.0000 ***		

Source: own calculations

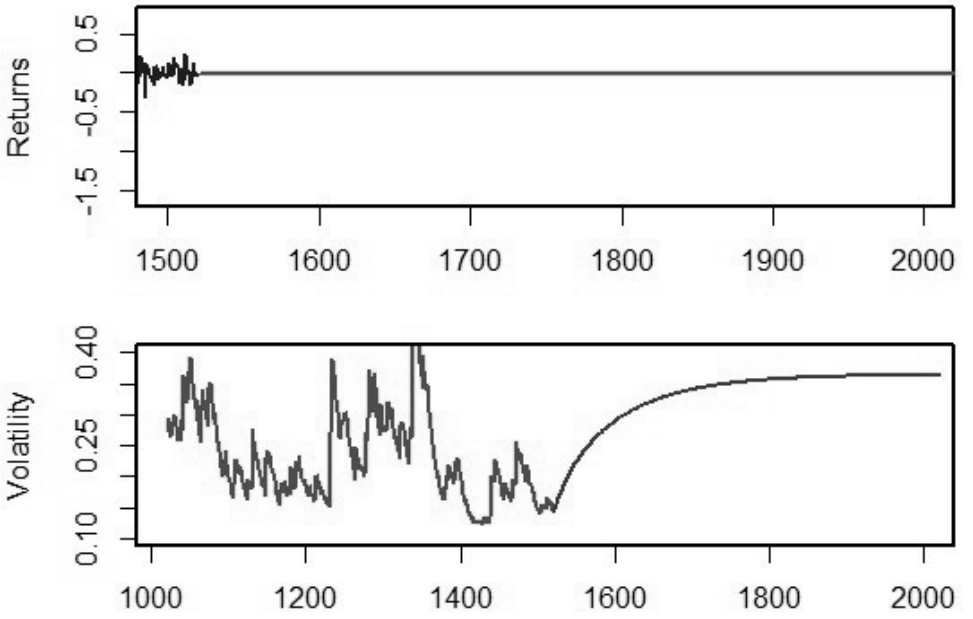
Both the ARCH and GARCH coefficients (0.115714 and 0.876846) are statistically significant.

The sum of these coefficients is 0.99256 which means that the shock to fluctuations affect conditional variations. If $\alpha 1 + \beta 1$ was equal to 1, we would use the integrated GARCH (1,1), so called IGARCH (1,1).

From the program R for AR(1,8,12)-GARCH(1,1) model application, we obtained the following conditional variation of allowances prices (6). After extraction, we can follow the development of the time series volatility of the prices of emission allowances (Figure 3).

$$h_t = 0.001385 + 0.115714\,\varepsilon_{t-1}^2 + 0.876846 h_{t-1} \quad (6)$$

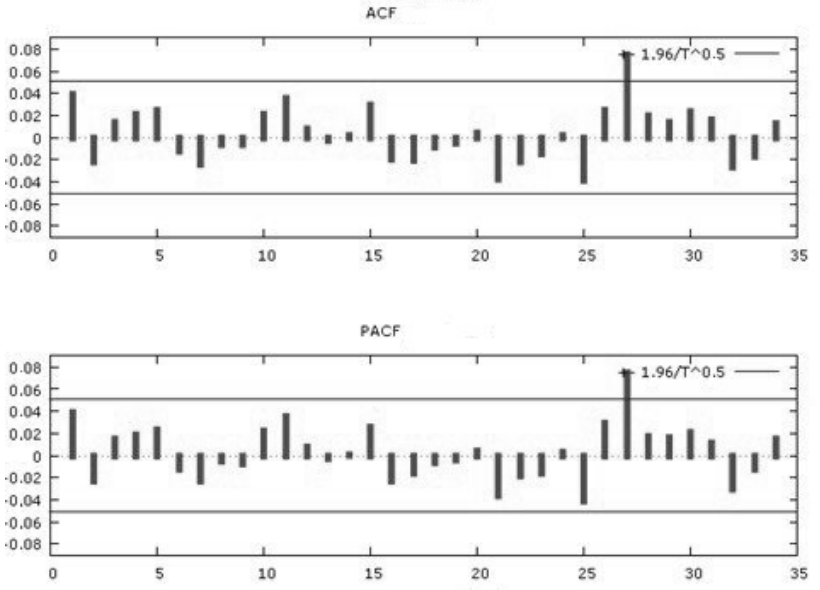
Figure 3: Prediction returns and volatility of emission allowance prices



Source: own calculations (SW RJ)

Given the long-term horizon of the prediction, the allowance price is relatively stable (the analysis is performed through BAU scenario), therefore is its volatility low. Verification (model diagnostics) is performed on the basis of obtained standardized residues. For testing standardized residues, we use the same tests as for the logarithmic returns (ACF, PACF, Box - Pierce and Ljung - Box test a subsequently testing of normality) with the difference of applying these tests on other data, i.e. instead of the logarithmic returns, we apply the data to the standardized residues obtained from parameter estimations. The un-correlation was checked by the selective autocorrelation function of standardized residues.

Figure 4: Testing the autocorrelation: standardized residues ACF and PACF of GARCH (1,1) model



Source: own calculations

From Figure 4 follows that the models of mean value and also of conditional variance were chosen adequately but the conditional heteroscedasticity could not be removed completely. More significant values remain in points of 26 multiples. This fact might be removed by modification of GARCH model to P-GARCH for modeling the seasonality in volatility. This model is discussed by for instance Alan Bester (BESTER, 1999).

Conclusions

The European Emissions Trading System suffers from a long-termexcess of allowances. After complicated and lengthy negotiations a two-phase reform was introduced in order to improve the functionality and stabilize the price. First, in the context of backloading, the volume of EUAs sold at auctions in the years 2014 to 2016 was reduced by 900 million euros. Later, Market Stability Reserve was approved, but the excess of allowances will not begin to be disposed of until 2019.

The second part of this paper contains the methodology of modeling the volatility with the use of ARCH and GARCH models. Then we modeled the cluster model AR(1,8,12)-GARCH(1,1), the output of which is the detection of the conditional variance. The model was verified and we can conclude that model thus identified is adequate for predicting the volatility of the prices of emission allowances.

The results of this study confirm that to predict the conditional variance and then volatility, it is adequate to use the cluster model AR(1,8,12)-GARCH(1,1) without constant, where in the long-term, the square root of the conditional variance inclines towards stable value.

However, we also have to bear in mind that the market with emission allowances is characterized by the fact that it is a market with artificially created demand. It is also important to mention that several artificial shocks caused by the administration occurred during the period examined in this paper which could have some influence on the price of the emission allowances.

The aim of this paper was to assess possible dysfunctions of the system in the future based on examining the effectiveness of the EU ETS and the prediction of volatility in spot prices. The results confirm that for predicting conditional variance and subsequent volatility cluster model AR(1,8,12)-GARCH(1,1) without constant is the most suitable, while the root conditional variance tends to lean to a stable value in the long run. Volatility is very low, because the model works with the BAU scenario, where significant shocks are not recorded.

However, from the viewpoint of stability, 5-6 EUR/EUA is not sustainable. We can expect a slight growing of prices, but not sooner than in three years and in the meantime (without the intervention of the Commission), the price will change minimally as stated in the article. This situation could even bring an irreversible destruction of the system.

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Czech Textbook of Social Policy
Česká učebnice sociální politiky

JAROSLAV VOSTATEK

Krebs, V., et al.: Sociální politika (Social Policy), 6th revised and updated edition. Prague: Wolters Kluwer, 2015. 568 pp., English summary of 2 pages.

The sixth edition of the popular social policy textbook appeared at the end of last year. Similarly, to the previous editions, it has two key authors: professor Vojtěch Krebs and associate professor Jana Žižková who, each separately, wrote 7 and 6 chapters, respectively, of the total of 19 chapters in the textbook, and provided their contributions for other chapters in cooperation with the following colleagues: Jaroslava Durdisová, Magdalena Kotýnková, Jan Mertl, Olga Poláková, Helena Vychová and Petr Sunega.

Students of the University of Economics in Prague, University of Finance and Administration, as well as a number of other universities of both economic and other than economic disciplines appreciate not only the balanced presentation of the entire social theory and policy, but also the graphic layout which supports the actual studying of the issues: each chapter ends with a summary of the issues concerned and with a checklist of questions.

The first section of the textbook consists of 6 chapters; in addition to the explication of the fundaments and basic characteristics of social policy, social policy types (models), its functions and tools, it also offers a description of the social policy pursued by the European Union and of the post-1989 transformation of the Czechoslovak and Czech social policy. It also includes a chapter on poverty and social exclusion. The second section of the textbook comprises 13 chapters which essentially provide an explication of the different branches of social policy, with the largest branch – pensions – being divided into three chapters addressing the financing of pension security systems (in general), the Czech public "pension insurance" system and the Czech "supplementary pension insurance", which represents a constituent part of voluntary private pensions, following the recent abolition of the "retirement savings" pillar characterized as the "second" pillar (based on the World Bank typology). At the same time, the chapter on supplementary pension insurance incorporates also the issues of occupational retirement schemes and private life insurance. All chapters of the second section combine the explication of the world theory and policy with the explanation of the (trans)formation of the relevant segment of the Czech social policy and with explication of the current shape and parameters of these segments in the Czech Republic. It is a sophisticated approach to explain the issues, but the authors have done it very well thanks to their erudition in the relevant social policy fields. In more general terms, we can conclude that the authors present the fundamental problems of social policy as both a scientific discipline and practical action.

The textbook is addressed, in particular, to students at the University of Economics in Prague; nevertheless, it serves also as a basic study text for the master course of Social theory and policy, for instance, which is given primarily for the Public Administration

branch at the University of Finance and Administration. During our lectures, we focus on explaining more difficult themes and current topics; however, certain challenges are presented in a somewhat different diction, which is a commonplace model in having all subjects taught by different authors or for a different audience, as the case may be. To give an example here, let's take the explication of social policy types (models) which is contained in chapter 2 of the textbook. Vojtěch Krebs uses three ideal types of social policy as defined by R. M. Titmuss, the founder of the Social Administration discipline, later referred to as Social Policy; the Social Policy Department at the London School of Economics bears his name (Richard Titmuss Chair in Social Policy). What has proved useful for me in my lessons, at least so far, is a comparable typology of another, later social policy giant – G. Esping-Andersen, who distinguishes between three basic welfare regimes: liberal, conservative and social democratic. On top of that, I also add the neoliberal welfare regime (social model), which is significantly different from the liberal model, in accordance with the interpretation of many current experts. Naturally, it is not just a matter of stating the different approaches to explicating social policy which aims – as also indicated by V. Krebs – towards influencing (changing) the social reality or the social system, as appropriate (and subsequently describes liberalism, Christian social doctrine and democratic socialism). Certain structures from the period under the rule of a single (Communist) party still prevail not only in the Czech practice. Professor Krebs is also fully aware of the spread of neoliberalism, stating on page 90 that the neoclassic concept started to prevail in both the theory and the practice of economic and social policies since the turn of 1970's and 1980's, emphasizing particularly support for the market mechanism and the privatization processes, reduction of state regulation, and the need for "a sort of review of the welfare state". On page 167, to sum up, he notes that this represents a shift from the Keynesian model of economic and social policy to the neoclassic concept.

The chapter addressing the Czech "pension insurance" system describes, among other, the degree of solidarity and equivalence in this public pension pillar. The author also draws the conclusion that self-employed persons are in a more advantageous position in this regard. "The possibility to opt for a relatively low assessment base and the fact that the assessment base is determined on the basis of the difference between sales and costs result in the self-employed persons contributing proportionately less to cover the expenses of their pension than the employees." In the next paragraph, this redistribution in favour of self-employed is documented by figures: self-employed persons paid, "on the average, pension insurance contributions from an assessment base at the level of ca. 45% of the average employee assessment base in 2014. Consequently, employees largely "subsidize" self-employed persons, and this disproportion needs to be reduced" (p. 245). This is a topic; earlier this year, the minister of labour and social affairs Marksová sent a personal letter to all self-employed, encouraging them to increase, on a voluntary basis, their minimum assessment base used to calculate pension contributions, which also provides a basis for the calculation of their pensions – thus avoiding the risk of low pension in the future. In her letter, she also slightly insinuates a possible source of the (potential) problem: the application of flat-rate simplified expenses when calculating the income tax base. It is essential to add that the minimum level of self-employed pension contributions is fixed by law at 50% of the excess of the self-employed revenue over expenses. While the reduction of the pension contribution base to 50% of revenue less expenses is – generally speaking – debatable, the critics of this situation commonly omit the fact that the gross

wage of an employee cannot be simply compared with the "profits" of a self-employed person. The critics should at least take into account the total labour costs of the employer which are higher than the gross wages used to calculate the insurance contributions – in addition, I would like to point out that most social security contributions in the Czech Republic are paid by the employers (a total of 35% from the gross wage). We must also add other employee benefits, including the costs of holidays and leaves. In any case, the Czech self-employed persons act rationally; a voluntary increase of their assessment base used to calculate the social security contributions bears no fruit to them – to use hard words: they show financial literacy. Any simple savings plan is more advantageous for them. In my opinion, it is incorrect to talk about self-employed being largely subsidized by employees – in the system of the Czech "pension insurance" scheme. I consider a much bigger problem that the Czech public pension pillar is called "pension insurance", while its redistribution so strongly dominates over equivalence. From the legal perspective, we have a "Bismarck"-type system, but in reality it is a sort of "double Beveridge" system: the pension benefit is composed of a basic amount (9% of the national average wage) and the so-called percentage amount that – thanks to bend points and coefficients – strongly resembles the U.S. public pension system.

As a member of the "Expert Commission on Pension Reform", I very much appreciate that the textbook contains up-to-date results of the work undertaken by this Commission. However, the problem lies in the fact that the Commission has not come with many proposals and, furthermore, it has not analysed the current pension system. The textbook mentions the Commission's proposal for the steps to be taken to abolish the second pension pillar, as well as the proposed periodical revisions of the statutory retirement age and the "joint social insurance for spouses" which was, in the meantime, turned down by the experts of the Ministry of Labour and Social Affairs. In addition, the textbook aptly states that "the Pensions Commission" (existing for two years already) "has brought a number of other, often controversial and technically hardly feasible suggestions in the field of pension insurance for families with children and supplementary retirement insurance" (p. 253). A crucial problem in the Commission's activities – as pointed out in the textbook – concerns, in particular, the politically unclear social objective to be gradually achieved by the Czech pension reform.

The area of healthcare policy is even more complex: while old-age pensions appear as if they were all just about "money", there are much more stakeholders in the healthcare system: hospitals, doctors, pharmaceutical businesses, insurance companies, etc. The authors of the relevant chapter in the textbook mention also the role of environmental theory: environmentalists see the possible way out and the future of social policy in developing self-service groups based on "community self-help" (p. 343). This chapter, too, includes a detailed description of how healthcare services function in the conditions of variously designed schemes. Foreign authors will find here, in particular, the parameters of transformation of the Czech healthcare system and a detailed explication of the public health insurance system in the Czech Republic. The "performance-based model" of health care financing was designed in the first half of 1990's to guarantee health care accessibility and solve the problems with excess demand experienced in the previous model. However, this new model exhausted soon its financial resources in practice and had to be replaced by a combined financing system for services provided by health institutions. The authors

emphasize that the public healthcare system lacks mechanisms such as economy. Finally, the authors conclude that there are only a few countries worldwide that would have, as the Czech Republic, such an abundant and profound history of healthcare security system, which is based on the citizens' own responsibility while applying the basic principle of solidarity. The current discussions about the financing of the Czech healthcare system confirm that the Czech healthcare policy is not appropriately embedded in the comprehensive social policy, which is also the case for other policy branches.

I recommend the book to all those who are interested in gaining a deeper insight into social policy issues.

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